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Besides the author's separates, and in addition to the regular edition of the Bulletin, 100 copies were issued in signatures as printed, each signature bearing at the bottom of the first page the date of publication.

Article I.—A PRELIMINARY STUDY OF THE GRACKLES OF THE SUBGENUS QUISCALUS.

By Frank M. Chapman.

The seventeen members of the genus *Quiscalus* fall into three natural groups, or subgenera, which are known as *Holoquiscalus*, *Megaquiscalus*, and *Quiscalus*. *Holoquiscalus* contains nine species, which range through the West Indies to Trinidad, Cayenne, and Venezuela; *Megaquiscalus* contains five species, which range from Virginia southward along our eastern coasts, through Mexico and Central America to Bogota in Colombia, two of which enter our limits,—*Quiscalus major*, as just stated, reaching Virginia, while its southern limit is marked by the northern boundary of the range of *Quiscalus macrourus*, or about the mouth of the Colorado River in Texas. The subgenus *Quiscalus* contains three forms, which are wholly North American and bear no close relationships to the other members of the genus. *Quiscalus æneus* breeds from the Rio Grande Valley to northern British America and from the eastern slope of the Rockies to the western slope of the Alleghanies, while from Massachusetts to Nova Scotia it reaches the Atlantic seaboard; *Quiscalus quiscula aglæus* is typically represented from New Orleans to Charleston and southward to the extreme point of the Florida peninsula; and *Quiscalus quiscula* breeds from the northern limit of the range of *aglæus* northward to the southern limit of the range of *æneus* in the lower Connecticut and Hudson River Valleys. Its northern limit, therefore, coincides with the boundaries of the Carolinian fauna.

These three birds form a group so widely separated from its nearest allies that its origin is not now determinable. A part of their range corresponds with that of *Quiscalus macrourus* and *Q. major*, and it is probable that, like these birds, they have been derived from neotropical ancestors.

Quiscalus æneus was described as a species by Mr. Ridgway in 1869, since which time it has been variously ranked as a species or subspecies by different writers, who either believed in or were unconvinced of its intergradation with *quiscula*. A question has also arisen, among those who regarded the two bird as only subspecifically separable, concerning the manner in which their intergradation is accomplished. Is one bird an imperfectly differentiated offshoot of the other, and are the connecting intergrades geographical intermediates, or have we here two distinct species whose intergradation is due to interbreeding where the confines of their respective habitats adjoin? In other words, the question is one of geographical variation versus hybridization, and the object of this paper is to present the facts of the case so far as they are determinable by the material available for study.

The generous and active coöperation which the specialist receives in bringing together large series of specimens for detailed comparison is an important and characteristic feature of ornithological research in America. The uniform courtesy with which a request for the loan of material is granted enables the student to form at once much larger collections than through his own unaided efforts he could gather in years. Thus, through the assistance of fellow-workers, I have examined over 800 specimens of our Grackles, but, I regret to say, even this large number has proved insufficient to complete the chain of facts, without which we cannot hope to draw satisfactory and final conclusions concerning the exact relationships of the birds under consideration. The concluding table gives the number of specimens I have examined and from whom they were received. To each of the gentlemen mentioned therein I desire to express my very hearty thanks for the aid they have so freely given me. To Mr. Brewster, Mr. Ridgway, Dr. Warren, Dr. Avery, Mr. Austin F. Park, and Mr. J. T. Park, I am particularly indebted for especial efforts in my behalf.

Before proceeding to a discussion of the relationships of the three birds it will be necessary to give some attention to their coloration and diagnostic characters. It may here be mentioned that all the comparisons have been based entirely on breeding males; that is, on birds taken later than April 15, a date when nesting has begun and the migration is practically over.

Quiscalus æneus.

Adult Male in the Breeding Season.—The following description of a typical male is based on the examination of eighteen breeding specimens, from Erie, Penn., Wheatland, Ind., and Mt. Carmel, Ill. Head and neck purplish steel blue, more purplish anteriorly ; back, rump, and underparts rich, metallic olivaceous bronze, or brassy bronze ; upper and under tail-coverts purplish brassy ; tail reddish purple, the exposed portions of the feathers with brassy reflections ; primaries blackish, secondaries and wing-coverts of the same color as the tail, but the colors are richer and more intense, the coverts broadly tipped and edged with brassy.

Variations.—Head and Neck : The variations of the head and neck are the same as those which occur in *quiscula ;* that is, there are three types of coloration with their various degrees of intergradation. Briefly, these are (1) the purple type, with more or less bronzy reflections, this closely resembling the color of the same parts in *aglæus ;* (2) the steel-green or bluish-green, and (3) the steel-blue or purplish-blue, previously described, which occurs in about twenty-five per cent. of the specimens examined.

Back and Underparts.—The colors of the neck and body are very clearly defined ; there is, however, an occasional slight overlapping of the steel blue on the bronze, the result being a few purple-tipped bronze feathers at the line of juncture of the two colors ; the back and underparts themselves vary only in intensity and brilliancy of coloration ; earlier in the season they are brighter and more brassy, later darker and more deeply olivaceous bronze.

Wings and Tail.—The wings and tail present no variations other than those incident to wear and exposure of plumage.

Adult Female in the Breeding Season.—The following description of a typical female is based on the examination of thirteen breeding specimens from Erie, Penn., Kankakee marshes, Ind., and Mt. Carmel, Ill. The differences existing between male and female specimens of *æneus* consist simply in brilliancy of coloration. The pattern of coloration is exactly the same ; the purple, blue, or steel blue of the head and neck are as sharply defined in the female as in the male ; the back always shows at least a trace of bronze, and the brightest specimens cannot be distinguished from dull-colored or worn males.

Quiscalus quiscula.

Adult Male in the Breeding Season.—The following description of males is based on the examination of fifty-one breeding specimens from West Chester, Penn. The range of variation in *quiscula*, as represented by this series from one locality, is so great that it is not possible to select a specimen which shall serve as a type for the description of the species. There are three distinct phases of coloration, which may be termed (1) the bottle-green, (2) the bronze-purple, and (3) the brassy bluish-green. Between these phases there is every degree of intergradation, and the result is a confusion of characters which require detailed description.

Two specimens of this series agree with phase No. 1, or the bottle-green phase; they have the head and neck steel blue; but so far as coloration goes, in other respects, closely agree with true *aglæus*.

Fifteen specimens are typical of phase No. 2, or the purple-bronze phase. In this phase the head is either purple, steel blue, or steel green; the feathers of the back and underparts are widely margined with bronzy purple, there is a subterminal iridescent band, and a concealed base, varying from brassy bronze to bronzy purple. The rump varies from bronze, or brassy bronze, to bronzy purple, in two specimens the feathers are tipped with iridescent spots; the upper tail-coverts are bronzy purple; the wings and tail agree in coloration with phase No. 1, but are heavily glossed and margined with bronzy purple. Eleven specimens are intermediate between phases No. 1 and No. 2, the intergradation being effected by a decrease in the width of the bronze-purple terminal bar characteristic of the feathers of the back in phase No. 2, followed by a proportionate increase in the width of the bottle-green bar of phase No. 1. Held in certain lights these intermediate specimens may appear typical of either phase as one receives the green or bronze-purple reflections from them. In phase No. 3 (nine specimens) the brassy bluish-green phase, the head and neck agree in coloration with phase No. 2; the change in the color of the feathers of the back is effected by the substitution of a brassy bluish-green terminal bar for a bronze-purple one, by the less clear definition of the iridescent subterminal band, by an increase in the width and constancy of the basal brassy bronze, which in two specimens is not concealed, the terminal brassy bluish-green being then proportionately reduced. In four specimens the rump and lower back are brassy bronze or olivaceous bronze; in the remaining four it is brassy bronze with purplish reflections; in one of the last four the feathers of the rump have terminal iridescent spots; the upper tail-coverts, wings and tail agree with those of phase No. 2. Thirteen specimens are intermediate between phases No. 2 and No. 3, these intergrades being produced by a mingling of the bronze-purple and brassy bluish-green colors of the back. Phases No. 1 and No. 3 do not intergrade directly, No. 2 being a transitional phase between them.

Adult Female in the Breeding Season.—The following description of the female is based on the examination of sixteen breeding specimens from West Chester, Penn. The female in *quiscula* presents fully as much variation in color as the male, the less conspicuous coloring, however, renders it difficult to properly determine the color phases corresponding to phases of the males. The head is variously purple, steel blue or steel green; seven specimens have the feathers of the back basally purple, bronze purple, or brassy bronze, with subterminal iridescent bars and terminal bands of bronze purple or brassy bluish-green; five specimens are dull, lustreless bronze with slight purplish reflections; four specimens are intermediate between these two phases. The variations of the rump, wings, and tail correlate with those of the back.

Quiscalus quiscula aglæus.

Adult Male.—So far as coloration goes *Quiscalus quiscula aglæus* represents the extreme development of phase No. 1 of *Quiscalus quiscula*. The differences in color which exist between Washington and Chester County, Penn., specimens of this phase and examples from South Florida consist in the greater average intensity of the green of the back, the southern birds being, as a rule, slightly darker, and in the color of the head. In Florida birds this part varies from a steel blue to bronzy purple, the last being the prevailing color, while in the northern bird steel blue is the prevailing shade. Many Florida birds, however, can be exactly matched in color by northern specimens. Further variation in my series of sixty males from Southern Florida is shown in the direction of phase No. 2 of *quiscula*, of which there are two specimens, while twelve others are intermediate between phases 1 and 2; No. 1, therefore, being represented by forty-six specimens, or seventy-six per cent., while in Chester County only four per cent. of the specimens can be referred to this phase.

Adult Female.—The females of *aglæus* do not present so wide a range of variation as do the females of *quiscula*. The most highly-colored specimens, however, are brighter than the extremes in *quiscula*. Such specimens have the feathers of the back rich purple basally, while the tips are occupied by an iridescent band.

In size *aglæus* averages smaller than either *æneus* or *quiscula*, but has the bill actually as well as proportionately longer. The succeeding table of measurements shows in detail the differences in size which exist between the three forms.

Lack of a large series of breeding specimens has, in the present case, forced me to use winter birds. With little doubt, however, they represent the resident bird, and in any event all of the phases mentioned are shown by summer males.

Young Birds.—Young birds of the three forms in first, or nestling, plumage are indistinguishable from one another, but when the first plumage is fully grown slight purplish or bronzy reflections may, in *quiscula* and *æneus*, give some indication of parentage. Of *aglæus* my only young specimen is in incomplete first plumage. Soon after the acquisition of the first plumage a complete molt, including wing and tail-feathers, occurs, and the bird passes at once into the full adult plumage with a head which may be purple, steel blue or steel green, showing that the variation in the color of the head is not due to age.

I have found no evidence of a molt in the spring.

Measurements.—The differences in size, which exist between these three forms, are too slight to be of diagnostic value in individual cases, the range of variation in either form completely overlapping the average differences. Still a study of average measurements, based on series of specimens taken throughout the range of each form, develops some points of interest.

Quiscalus æneus presents a slight but regular increase in size northward, the accompanying table showing in detail the differences in dimension of specimens taken throughout its habitat. On the whole it appears to be a somewhat smaller bird than *quiscula*, with perhaps a slightly longer tarsus. A comparison of the average measurements of District of Columbia specimens with those of Mt. Carmel, Ill., and Wheatland, Ind., examples, and of the West Chester, Penn., series with the series from Erie, may be considered to show the differences in size which exist between the two species.

In *aglæus* and *quiscula*, in passing from the South northward, we find about the same increase in size shown by *æneus*; the wing and tail become longer, the bill thicker, but the length of this member decreases; Florida specimens (*aglæus*) having an actually, as well as relatively, longer bill than northern specimens. A series of twenty-five birds from Shelter Island, N. Y., present an exception to the rule of increase in size northward, and average smaller than the Washington specimens. Most of the Long Island birds, however, were taken in June, and their apparently smaller size may be due to worn plumage.

Average Measurements of Breeding Males of *Quiscalus quiscula* and *Quiscalus quiscula aglæus*.

Locality.	No of Specimens.	Wing.	Tail.	Tarsus.	Expos'd Culmen	Depth of Bill at Nostril.
Indian River, Fla.	24	5.38	4.90	1.45	1.25	.42
District of Columbia	11	5.62	5.14	1.44	1.20	.47
West Chester, Penn.	50	5.66	5.18	1.47	1.18	.46
Shelter Island, N. Y.	25	5.56	4.94	1.46	1.17	.45

AVERAGE MEASUREMENTS OF BREEDING MALES OF *Quiscalus æneus*.

LOCALITY.	No of Specimens.	Wing.	Tail.	Tarsus.	Expos'd Culmen	Depth of Bill at Nostril.
San Antonio, Tex.	2	5.34	4.70	....	1.23	.49
Cook County, Tex.	2	5.47	4.83	....	1.19	.47
Warner, Tenn.	6	5.50	5.11	....	1.18	.44
Bell, Ky.	2	5.54	5.28	1.48	1.20	.46
Mt. Carmel, Ill	3	5.56	5.16	1.49	1.16	.44
Wheatland, Ind.	3	5.51	5.31	1.48	1.12	.45
Erie, Penn.	8	5.60	5.09	1.53	1.15	.44
Fort Snelling, Minn.	3	5.59	4.91	1.53	1.17	.46
Pembina and Ft. Rice, N. Dak.	3	5.65	5.24	....	1.17	.44
Vicinity of Cambridge, Mass.	21	5.62	5.04	1.46	1.21	.47
Vermont, Maine & New Brunswick.	9	5.71	5.36	1.45	1.19	.46

SUMMARY.—In order that the discussion of the inter-relationships of the three forms just described may be easily followed, it is important that their plumages should be thoroughly understood Omitting all reference to the color of the head as too variable a character to be used in diagnosis, we may know *æneus* as a bird in which the back and underparts are metallic brassy, or olivaceous bronze without iridescent bars in any part of the plumage. *Quiscula* assumes three phases of coloration which merge into one another in the order named: first, the bottle-green; second, the bronze-purple; and third, the brassy bluish-green. In each of these phases the feathers of the back and underparts are banded with iridescent bars of varying extent. *Quiscalus quiscula aglæus* represents the highest development of phase No. 1 of *quiscula*. Keeping these points of difference before us, we may follow the variations presented by each form throughout its range.

BREEDING RANGE OF *Quiscalus æneus*.—I shall here consider *æneus* only as my material typically represents it, its relationships and intergradation may be treated of through *aglæus* and *quiscula*. The description given of a typical series of *æneus* covers all the variations presented by a series taken throughout its range, and it will not be necessary to discuss these specimens in detail. Briefly it may be said that for a bird having so wide a breeding range *æneus* presents remarkably slight variations, either in color or size.

The localities represented by breeding specimens (see the accompanying map) are the following:

Texas, San Antonio, (Attwater), Cook County (Ragsdale). **Louisiana,** Clinton (Kohn). **Alabama,** Greensboro' (Avery). **Tennessee,** Warner, Hickman County (Park). **Kentucky,** Bell, Christian County (Bacon). **Illinois,** Mt. Carmel (Ridgway). **Indiana,** Wheatland (Ridgway). **Pennsylvania,** Erie (Sennett), Meadville (Sennett). **Michigan,** Oden (Brewster), Petoskey (Dwight). **Minnesota,** Fort Snelling (Mearns). **Dakota,** Fort Rice (Allen), Pembina (Coues). **Wyoming,** Laramie Peak (Hitz). **Colorado,** Denver (Henshaw), Fountain (Aiken). **Montana,** Fort Custer (Bendire). **British America,** Fort Resolution (Kennicott), Great Slave Lake, Big Island (Reid). **Ontario,** Hamilton (McIlwraith). **New York,** Leyden, Lewis County (Fisher), Locust Grove (Fisher), St. Regis Lake (Roosevelt). (**Hudson Valley, Massachusetts** and **Connecticut** will be considered under *quiscula.*) **Vermont,** Middlebury (Knowlton). **Maine,** Calais (Boardman), Oxford County (Brewster), Ft. Fairfield (Dwight). **New Brunswick,** Woodstock (Adney), Hillsborough (Dwight).

Mr. William Palmer[1] observed Grackles, which undoubtedly were *æneus*, at St. John's, N. F. A line connecting the two most northern points from which the species has been recorded, therefore, corresponds closely with the northern limit of trees.

Distribution during the Migratory Season and in the Winter.—During both the spring and fall migrations *æneus* occurs east of the Alleghànies, but the centre of abundance in the winter seems to be the lower Mississippi Valley; and the bird is apparently unknown from the South Atlantic seaboard. In the Atlantic States, Aiken, South Carolina, is the most southeastern locality represented; there are no specimens from Georgia, and the species has never been recorded from Florida. There are numerous specimens from Alabama, Louisiana, and Texas—the most southern locality represented in the last-named State being Banquette, near Corpus Christi. There is no record from Mexico, but at Eagle Pass Mr. Negley[2] reports the species as arriving in the spring from the South, and there can be no doubt, therefore, that some birds winter south of the Rio Grande.

The eastward extension of *æneus* through New York and Massachusetts to the Atlantic coast, and thence northward to

[1] Proc. U. S. Nat. Mus., XIII, 1890, p. 263.

[2] Cooke, Bird Migration in the Miss. Valley, 1888, p. 175.

New Brunswick, renders its habitat unique among North American birds. This singular eastern distribution, however, is in a measure paralleled by that of *Lanius ludovicianus*, and has probably occurred in the same manner.[1] The Loggerhead Shrike has apparently reached northern New England by passing from the Mississippi Valley eastward along the Great Lakes, and is thus regularly found breeding in central New York and northern New England, but is known only as a migrant in the lower Hudson and Connecticut River Valleys.

BREEDING RANGE AND RELATIONSHIPS OF *Quiscalus quiscula aglæus* AND *Quiscalus quiscula*.—We will here ignore the distinction created by the name *aglæus* and consider *quiscula* as a species ranging from the southern extremity of Florida northward to the Connecticut River Valley. We have already seen that in southern Florida phase No. 1 of *quiscula*, or the bird known as *aglæus*, reaches its highest development, while phase No. 2 is barely represented, and No. 3 is entirely wanting. We may now trace the distribution and relationships of these phases with one another and with *æneus* by considering in geographical order the entire series of specimens at our disposal. It will soon be evident that without a large number of examples the exact status of the birds of any one locality cannot be accurately determined.

Northern Florida.—Three specimens from Gainesville (Bell and Chapman) are referable to phase No. 1, one is intermediate, and two agree with phase No. 3. Two specimens from Rosewood (Maynard), two from the lower Suwanee River (Chapman), and one from Talahassee (Brewster), represent phase No. 1, while a second specimen from the last-mentioned locality is intermediate between phases Nos. 1 and 2.

Georgia.—A single specimen from St. Mary's (Brewster) is typical of phase No. 1.

Alabama.—Sixteen specimens, collected by Dr. Avery at Greensboro', are, in some respects, different from any I have examined. For the present, however, they may be classified as

[1] *Cf.* Merriam, Bull. N. O. C., III, 1878, p. 55.

follows: Phase No. 1, two; intermediates, six; phase No. 2, seven, while the sixteenth specimen, taken July 17, 1889, is typical *æneus*. Unfortunately the late date at which this bird was secured renders its breeding at Greensboro' open to question, and it is not improbable it may be a wanderer from a more northern locality.

A male from Anniston (Avery) is intermediate between phases Nos. 1 and 2.

A male from Coosada (Brown) is referable to phase No. 1.

Louisiana.—Of seventeen males from New Orleans, Madisonville, and Mandeville (Kohn, Fisher and Galbraith), eight are referable to phase No. 1, seven are intermediates, while the remaining two are typical of phase No. 2. From Clinton, about fifty miles northwest of New Orleans, there is a specimen of *æneus* taken by Mr. Kohn, June 6, 1888. The specimen has the anterior interscapulars lightly tipped with bluish green, but the difference from typical *æneus* is so slight that it is difficult to say whether this variation is purely individual or not.

Dr. F. W. Langdon records "*Quiscalus quiscula*" as probably breeding in West Baton Rouge Parish.[1] I have not seen the specimens on which this record is based, and cannot say, therefore, which phases of *quiscula* they represent.

Mr. C. W. Beckham has recorded *æneus* as occurring in April at Bayou Sara,[2] but does not state that he found it breeding.

Tennessee.—Eleven specimens taken from "one colony" at Warner, Hickman County, by J. F. Park, are all typical *æneus*. Dr. Fox writes me concerning his record of the occurrence of *æneus* and *quiscula* at Rockwood, Roane County, that "the birds were not breeding at the time they were shot." He further says that "the first flock was seen March 16, and none were met with again until the 26th, after which a flock could be found on or near a certain large tree every day of my stay." The specimens collected by Dr. Fox are now in the United States National Museum, and have been loaned me by Mr. Ridgway. The March specimens we may ignore as probable migrants, but it

[1] Journ. Cincinnati Soc. Nat. Hist., IV, 1881, p. 150.

[2] The Auk, IV, 1887, p. 303.

is quite probable that two males, taken April 11 and 16 respectively, represent the resident form. The first is *quiscula* intermediate between phases 1 and 2, the second typical of phase 2.

Kentucky.—The specimens on which Dr. L. O. Pindar based his interesting record of the breeding of *quiscula* and *æneus* in separate colonies in Fulton County[1] are unfortunately not now in existence.

Dr. Pindar writes me: "I have secured and perfectly identified specimens of each variety, and have found the nests and eggs of each; *æneus* far outnumbers *quiscula*, and during the breeding season they keep apart from each other." Fulton County is in western Kentucky, on the Mississippi River, and it is not impossible that this locality may represent a northern extension of a phase of *quiscula* in the Mississippi Valley.

The importance of this record is evident, but its exact bearing on the question at issue cannot be determined until we know what phase of *quiscula* occurs in Fulton County.

Two specimens from Bell, Christian County, southwestern Kentucky (Bacon), are typical *æneus*.

South Carolina.—Nine specimens taken throughout the year, near Charleston (Wayne), are typical of phase No. 1 of *quiscula* (=*aglæus*), which, Mr. Wayne writes me, is the only form that breeds in his vicinity.

North Carolina.—A male taken at Raleigh, June 19 (Brimley), agrees with phase No. 3. This, it will be observed, is the first appearance of this phase.

District of Columbia.—In a series of sixteen specimens taken at and near Washington, three (Fisher and Richmond) are referable to phase No. 1, six (Fisher, Jouy and Richmond) are intermediates between this phase and phase No. 2, two (Richmond) agree with phase No. 2, and four (Fisher) are intermediates towards phase No. 3. The last-named phase is not represented, and the sixteenth bird is a typical example of *æneus*, taken April 17, 1886, by Mr. C. W. Richmond. In 'The Auk,'

[1] The Auk, VI, 1889, p. 314.

Vol. V, p. 19, Mr. Richmond has recorded the capture of this bird, and also of another of the same species, taken April 6, 1887. Both were secured "in a grove of cedars occupied by a colony of Purple Grackles."

Maryland.—Of three specimens from Sandy Spring (Fisher) two are intermediate between phases Nos. 1 and 2, and one is typical of phase No. 3.

Pennsylvania.—In the splendid series of fifty-one breeding males collected in Chester County by Dr. B. H. Warren and Mr. G. W. Roberts, we for the first time find all three phases of *quiscula* associated, and can thus study their inter-relationships to better advantage. Of phase No. 1 there are two typical specimens, which are connected with phase No. 2 by eleven specimens, showing every stage of intergradation. Fifteen specimens are typical of phase No. 2, which in turn is connected with phase No. 3 by thirteen intermediates. Of phase No. 3 there are nine specimens, while one specimen is intermediate between this phase and *æneus.*

In going westward and northwestward from Chester County, and thus approaching the range of true *æneus*, we find *quiscula* represented by phase No. 3 or its intermediates. Thus at Carlisle (Baird) one specimen is intermediate between phases Nos. 2 and 3 and one agrees with phase 3. One example from Dauphin County (Warren) is referable to phase No. 3; one from Centre County (Warren) is intermediate between phase No. 3 and *æneus*, while three specimens from Williamsport (Koch and Warren) are respectively referable to intermediates between phases Nos. 2 and 3, phase No. 3, and intermediates between this phase and *æneus.* From Athens I have two specimens which are between phase No. 3 and *æneus*; from Towanda (Dwight) one example of *æneus*, and from Port Jervis (Dwight), on the northeastern boundary of the State, two specimens, one of which is between phase No. 3 and *æneus*, while the other is *æneus.*

New Jersey.—Of eight specimens from Monmouth County (Zerega), Princeton (Scott and Nicholas), and Raritan (Southwick), four agree with phase No. 2, two are intermediate and two agree with phase No. 3. In a series of seven specimens from

Morristown (Thurber) two are referable to phase No. 2, two are intermediate between this phase and phase No. 3, and three agree with phase No. 3. This locality is interesting as being the last one in which phase No. 2 is typically represented.

New York.—In passing up the Hudson River Valley *quiscula* again approaches the habitat of *æneus*, and the intergradation of the two birds is at once rendered evident. Three specimens from New York City (Dwight) are phase No. 3, one from Westchester County (Fisher) is between this phase and *æneus*, one from Sing Sing (Fisher) agrees with phase No. 3, and a second specimen is intermediate towards *æneus*. Two examples from Highland Falls (Mearns) are *æneus*, while of seven specimens from Troy (A. F. Park) one is referable to phase No. 3—its known northern limit in the Hudson River Valley,—four are intermediates towards *æneus* and two are typical *æneus*.

We may conclude our analysis of specimens by following *quiscula* from the east end of Long Island northward up the Connecticut River Valley into Massachusetts.

Long Island.—The collections of Mr. Brewster, Mr. Dutcher and the American Museum furnish a series of forty-one beautifully prepared skins which were collected by Mr. W. W. Worthington at Shelter Island. This series is most instructive and clearly shows phase No. 3 of *quiscula* to be connected with true *æneus* by such finely graduated steps that it would here be impossible to draw a line between them. Phase No. 2 has now disappeared, and we have only four specimens intermediate between it and phase No. 3. Phase No. 3 here reaches the highest stage of its development and is represented by twenty-nine specimens or (with its intergrades towards *æneus*) ninety per cent. of the whole as against twenty per cent. in Chester County, Pennsylvania. Seven specimens are intermediate between phase No. 3 and *æneus*, of which there is one typical specimen taken June 16, 1886.

Connecticut.—The Long Island specimens have prepared us for what the Connecticut series unquestionably proves, that is, the complete intergradation of phase No. 3 of *quiscula* with *æneus*. Of fifteen specimens, collected by Mr. Sage at Portland, five are

TABLE SHOWING THE DISTRIBUTION OF *Quiscalus quiscula* AND ITS SEVERAL PHASES, BASED ON BREEDING MALES.

LOCALITY.	*Quiscalus quiscula.*						*Quiscalus æneus.*
	Phase No. 1 =*aglæus.*	Intermediates.	Phase No. 2.	Intermediates.	Phase No. 3.	Intermediates.	
South Florida	46	12	2				
North Florida	8	2	2				
St. Mary's, Ga	1						
Greensboro', Ala	2	6					1
Anniston, Ala		1					
Coosada, Ala	1						
New Orleans, La. / St. Tammany Parish, La.	8	7	2				
Clinton, La							1
Warner, Tenn							5
Rockwood, Tenn		1	1				
Bell, Ky							2
Charleston, S. C	9						
Raleigh, N. C					1		
District of Columbia	3	6	2	4			
Sandy Spring, Md		3			2		
Chester County, Penn	2	11	15	13	19	1	
Carlisle, Penn				1	1		
Dauphin County, Penn					1		
Centre County, Penn						1	
Williamsport, Penn				1	1	1	
Athens, Penn						2	
Towanda, Penn							1
Port Jervis, N. Y						1	1
Monmouth County, N. J			1				
Princeton, N. J			2	2	1		
Raritan, N. J			1		1		
Morristown, N. J			2	2	3		
New York City, N. Y					3		
Westchester County, N. Y						1	
Sing Sing, N. Y					1	1	
Highland Falls, N. Y							2
Troy, N. Y					1	4	2
Shelter Island (L. I.), N. Y				4	29	7	1
Portland, Conn					5	5	5
East Hartford, Conn					3	5	2
Woods Holl, Mass					2	14	10
Taunton, Mass					1		
Monomoy Island, Mass						1	
Framingham, Mass					3	2	
Quincy, Mass						2	5
Cambridge, Mass					1		4
Belmont, Mass							3
Lexington, Mass							1
Watertown, Mass							8

referable to phase No. 3, five are intermediates between it and *æneus*, and five are typical *æneus*. Of ten specimens, collected by Mr. W. E. Treat at East Hartford, three agree with phase No. 3, five are intermediates and two are *æneus*.

Massachusetts.—Twenty-six specimens from Woods Holl (Edwards) are for the most part without date, but are evidenly spring birds. They further illustrate the gradual replacement of *quiscula* by *æneus*. Only two specimens agree with phase No. 3, fourteen are intermediate between it and *æneus*, while ten specimens are true *æneus*.

Other Massachusetts specimens show that phase No. 3 of *quiscula* is occasionally found even as far north as Cambridge; beyond this, however, *quiscula* in any phase of plumage appears to be unknown, and true *æneus* is found alone. One example from Taunton (Cahoon) agrees with phase No. 3; one from Monomoy Island (Cahoon) is intermediate between this phase and *æneus*; three specimens from Framingham (Eastman) are referable to phase No. 3, while two others from the same place are intermediates towards *æneus*; two specimens from Quincy (Frazar) are intermediate between phase No. 3 and *æneus*, while five additional specimens from the same locality are typical *æneus*; one example from Cambridge agrees with phase No. 3, the known northern limit of this phase, while four other specimens from Cambridge (Brewster), three from Belmont (Brown), one from Lexington (Maynard), and three from Watertown, are all true *æneus*.

Conclusions.—We may briefly summarize this review of our Grackles as follows: (1) *Quiscalus æneus*, throughout a breeding range which extends from the Rio Grande Valley to British America and New Brunswick, varies in coloration only in that comparatively limited part of its habitat adjoining the area occupied by *Quiscalus quiscula*, with which, at least from Pennsylvania to Massachusetts, it completely intergrades. (2) *Quiscalus quiscula*, an extremely variable form, assumes three phases of coloration, the first reaches its extreme development at the southern limit of the bird's range where the third phase is unknown, while the third phase is most highly developed at the bird's northern limit, where the first phase is unknown. The second phase connects the first and third, and is rarely found at either extreme, but is most abundant near the centre of the bird's habitat where, it is to be noted, all three phases, with their connectants, occur together. (3) The exact relationships of *quiscula* and *æneus* in the lower Mississippi Valley and northward along the Alleghanies to Pennsylvania are not at present known. (4) In the Alleghanies of Pennsylvania, in the Hudson Valley from Sing Sing to Troy, in eastern Long Island, in Connecticut, and in Massachusetts as far north as Cambridge, *quiscula* and *æneus* completely intergrade. (5) This intergradation is in every instance accomplished through phase No. 3 of *quiscula.*

Here, then, are the apparent facts of the case ; the evidence of to-day is still incomplete, the history of the past may be forever hidden by the veil of time.

It is, of course, inadvisable to theorize from insufficient data, and while I confess no satisfactory solution of the entire problem has presented itself to me, it will not be out of place to try and define its terms as they appear in the light of our present knowledge. First, is *æneus* a species? The aspect of the whole subject depends upon our reply to this question. We have proven beyond doubt that *æneus* and *quiscula* do intergrade; if now we can show their specific distinctness, it follows as a matter of course that their intergradation is due to causes other than those which produce intergradation among subspecies. If *æneus* and *quiscula* are only subspecifically separable, *quiscula* is undoubtedly an offshoot or subspecies of *æneus.* Why then, assuming this to be the case, should this form prove remarkably constant throughout an immense area, and then in a comparatively limited portion of its habitat become abruptly differentiated into three color phases, the extremes of which are as widely separated from each other as *æneus* is from either. Are there any known climatic or geographic conditions which will account for this change ? To be more explicit, we find typical *æneus* is the only form which breeds at Warner, Tenn., while at Greensboro', Ala., 200 miles south, *quiscula* is the breeding form. Are there any environmental causes which will differentiate *quiscula* from *æneus* in this intervening area? If so, their action has certainly not been shown in the case of more susceptible species. Or, again, in the vicinity of New York *quiscula* is the common form, while in the region about Boston *æneus* is the prevailing bird. Have we among the species which breed at both localities any other instances presenting similar variation? Finally, we have seen that at certain localities *quiscula* and *æneus*, and their intergrades, occur in about equal numbers. Have we among North American birds any instance in which two subspecies are found breeding and intergrading at the same locality?

These are fair test questions, based on known facts in the history of *æneus*. If we can answer them satisfactorily in the affirmative, there is nothing unusual in the case, and *æneus* and *quiscula* simply conform to laws which obtain among undoubted subspecies. If, on the contrary, the case is without parallel, and environmental conditions will not account for the intergradation of these birds, can we do otherwise than admit their specific distinctness and explain their intergradation by hybridization?

For myself, I have no doubt that the latter view is the correct one. Certainly it explains the case in a far more satisfactory manner than do any other influences to which, so far as we know, the birds are subjected. Nor do I see any good reason why we should refuse to admit hybridization as a factor in the evolution of what we term species. There can be no question that, in spite of our test-book assertions to the contrary, we place too high a value on this word 'species.' And while we recognize the 'plasticity' of animal forms and their ready response to the influences of environment, we have been loth to admit that, so far as regular interbreeding was concerned, they are not distinct creations.

Difference in habit under what must necessarily be similar conditions will ever be an effectual barrier against the indiscriminate mixing of even closely-allied birds. But when two species whose natural economy, song, nidification, etc., are the same, and which agree in structural details and differ only in coloration, inhabit contiguous regions, is it unnatural that they should at first occasionally, and in the end regularly, interbreed? The evidence in proof of such intergradation is gradually accumulating, and in the future I think we shall be forced to recognize hybridization not only as a means which unites known forms, but which also gives rise to new ones.

I would not be understood as advocating an appeal to this cause whenever the facts of a case are apparently not to be explained by recognized evolutionary factors. To call an intermediate a 'hybrid' is an easy way of answering what may be a difficult question. But unless the hybridization has been proven, it is a reply which gives no information whatever, and proves a stumbling-block to more thorough investigation.

It is because of this too frequently unwarranted application of the hybridization theory that most ornithologists have refused to admit its now evident importance. It seems to me, however, that given sufficient data on which to base any theory of the relationships of two intergrading forms, and provided they are not so slightly differentiated that individual variation overlaps the differences which separate them, we should not be in doubt as to whether they are connected through the action of purely environmental causes or by the more direct action of hybridization. The nature of their intermediate characters, the fact that these characters do not correlate with environmental influences, the presence of both species in the area occupied by their intergrades, all should furnish evidence which will enable us to distinguish between hybrids and geographical intermediates.

It is true that such evidence can be derived only from extensive collections and careful field observations, but until both have been made, are we warranted in advancing any explanation of the relationships of connected forms.

NOMENCLATURE.—There result from this study two nomenclatural problems which are not easy of solution. The first relates to *Quiscalus quiscula*. This name conveys no exact meaning, and unless I have examined the specimens, in no instance have the published records of this bird been of service to me.

The only way out of this difficulty, which I see, is to adopt the method we use in writing of dichromatic species and follow the bird's name by its color-phase; or, in labeling, the numerals 1, 2, or 3 may be used to designate their respective phases. I have followed this plan in determining the material used in the present connection, adding the fraction ½ for intermediate specimens.

The second question is, shall we use a binomial or trinomial appellation for birds which intergrade by hybridizing? I would urge the former rather than the latter; first, because trinomials have been applied solely to subspecies, as we understand the term; whereas, in the case of hybridizing forms, the birds are species, and, so far as we can judge, have not been differentiated one from the other, but may be of equal age, or the offshoots of different ancestral stock; further, the intergradation is accomplished by a cause so different from that which gives rise to subspecies that the birds should not be nomenclaturally treated as such. Second, because hybridization, even on the most extended scale, differs from more or less frequent hybridization only in degree, and if we employ trinomials in the first instance there is no reason why we should not use them in every case where a complete connection between two species can be shown by a set of hybrid intermediates. In which case we should, for example, be obliged to say *Helminthophila pinus chrysoptera!*

To conclude, I have termed this paper 'A Preliminary Study,' because the available material has not been sufficient to enable me to present the subject in its entirety. The hybridization of *quiscula* and *æneus*, to my mind at least, is an established fact, but the results of this hybridization, as shown in the color-phases of *quiscula*, cannot be satisfactorily explained until we have numerous specimens from the lower Mississippi Valley northward along the Alleghanies to Pennsylvania. Indeed, specimens from any locality will be of assistance in a further study of the relationships of these birds, and I would earnestly request the loan of breeding male Grackles which I have not already examined. These may be sent to me at the American Museum of Natural History, New York City, whence they will be returned with as little delay as possible.

Sources and Number of Specimens Examined.

American Museum of Natural History	132
J. W. Atkins, Key West, Fla.	6
H. P. Attwater, Rockport, Texas	3
W. C. Avery, M.D., Greensboro', Ala.	19
C. Carrington Bacon, Bell, Ky.	2
William Brewster, Cambridge, Mass.	162
Cincinnati Society of Natural History, Cincinnati, Ohio	5

Columbia College, New York City	40
William Dutcher, " "	11
J. Dwight, Jr., " "	13
A. K. Fisher, M.D., Washington, D. C.	38
August Koch, Williamsport, Penn	8
Gustav Kohn, New Orleans, La	20
T. McIlwraith, Hamilton, Ont	2
E. A. Mearns, M.D., Fort Snelling, Minn	9
Austin F. Park, Troy, N. Y	17
J. T. Park, Warner, Tenn	11
Princeton College, Princeton, N. J	32
G. H. Ragsdale, Gainesville, Texas	2
W. C. Rives, M.D., New York City	2
George W. Roberts, West Chester, Penn	20
J. Rowley, Jr., New York City	3
J. H. Sage, Portland, Conn	42
George B. Sennett, New York City	22
United States National Museum	174
B. H. Warren, M.D., West Chester, Penn	49
A. T. Wayne, Charleston, S. C	1
Total	845

Article II.—THE NORTH AMERICAN SPECIES OF THE GENUS COLAPTES, CONSIDERED WITH SPECIAL REFERENCE TO THE RELATIONSHIPS OF C. AURATUS AND C. CAFER.

By J. A. ALLEN.

It has been known for more than thirty years that at certain points where the habitats of *Colaptes auratus* and *C. cafer* adjoin birds occur presenting the characters of the two species combined in the most heterogeneous manner, to account for which various hypotheses have been advanced. In order to arrive at the facts of the case, and to reach if possible a solution of the problem, I solicited, some months since, the loan of material for the prosecution of the investigation here detailed. Through the kindness of my fellow-workers, I have been able to bring together 785 specimens of the genus *Colaptes*, representing all of the North American and West Indian forms of the genus. These include nearly all of the available specimens in the leading public and private museums of this country, so far as they were considered especially desirable in the present connection.[1]

I am especially under obligations to Mr. Robert Ridgway, Curator of Birds in the U. S. National Museum, for securing for me the use of the specimens under his charge, and to Mr. William Brewster for the loan of one of the most extensive and valuable series of these birds extant. Captain Platte M. Thorne, 22d Inft., U. S. A., sent a series of unusual interest from Colorado and Montana, which he has kindly presented to this Museum. Valuable specimens have also been presented by Mr. L. Belding, of Gridley, Cal., and Mr. R. T. Lawrence, of Olympia, Wash. To various other ornithologists I am under deep obligations for the generous loan of specimens, to each of whom I tender my sincere thanks for their kind coöperation. The subjoined schedule indicates the source and amount of the material on which the present paper is based, arranged alphabetically under the names of con-

[1] The series of *C. auratus* from eastern North America might have been greatly extended had it been deemed necessary.

tributors. The number of specimens received from any single source does not necessarily justly represent the relative value of the contribution, since some of the smaller lots often contain specimens of the highest interest, either on account of the localities represented or from the peculiar character of the specimens themselves.

Charles F. Batchelder, Cambridge, Mass. 6 specimens.
Lyman Belding, Gridley, Cal. 5 specimens.
Capt. Charles E. Bendire, U. S. A., Washington, D. C. 2 specimens.
William Brewster, Cambridge, Mass. 206 specimens.
Frank M. Chapman, New York City. 9 specimens.
Charles B. Cory, Boston, Mass. 3 specimens (*Colaptes gundlachi*).
Jonathan Dwight, Jr., New York City. 12 specimens.
B. T. Gault, Glen Ellyn, Ill. 3 specimens.
E. W. Hasbrouck, Washington, D. C. 5 specimens.
Gustave Kohn, New Orleans, La. 8 specimens.
R. T. Lawrence, Olympia, Wash. 5 specimens.
Prof. John Macoun, Canadian Geological Survey, Ottawa, Can. 21 specimens.
Dr. Edgar A. Mearns, U. S. A., Fort Snelling, Minn. 15 specimens.
George H. Ragsdale, Gainesville, Texas. 2 specimens.
George B. Sennett, New York City. 22 specimens.
Ernest E. Thompson, Toronto, Can. 2 specimens.
Capt. P. M. Thorne, 22d Infantry, U. S. A., Fort Keogh, Mont. 27 specimens.
American Museum of Natural History, 178 specimens.
Princeton College, 38 specimens.
U. S. Department of Agriculture (through Dr. C. Hart Merriam), 10 specimens.
U. S. National Museum (through Robert Ridgway), 208 specimens.

The following statement indicates, in a general way, the geographical sources of the material used.

Alabama, 3 specimens.
Alaska, 8 specimens.
Alberta, Brit. Am., 4 specimens.
Arctic America (British), 9 specimens.
Arizona, 82 specimens.
Arkansas, 1 specimen.
Assinaboia, Brit. Am., 3 specimens.
British Columbia, 58 specimens.
California, 71 specimens.
Canada, 5 specimens.
Chihuahua, 23 specimens.
Colorado, 45 specimens.
Connecticut, 2 specimens.
Cuba, 6 specimens.
Dakota (both States), 12 specimens.
Florida, 46 specimens.
Georgia, 1 specimen.
Grand Cayman, W. I., 3 specimens.
Guadalupe Isl., L. Cal., 5 specimens.
Guatemala, 9 specimens.
Idaho, 1 specimen.
Illinois, 10 specimens.
Indiana, 7 specimens.
Indian Territory, 4 specimens.
Iowa, 10 specimens.
Kansas, 6 specimens.
Louisiana, 10 specimens.
Lower California, 72 specimens.
Maine, 4 specimens.
Maryland, 10 specimens.
Massachusetts, 16 specimens.
Mexico (southern parts), 10 specimens.
Michigan, 4 specimens.
Minnesota, 15 specimens.
Mississippi, 2 specimens.
Missouri, 1 specimen.
Montana, 44 specimens.
Nebraska, 7 specimens.
Nevada, 10 specimens.
New Brunswick, 3 specimens.

New Hampshire, 2 specimens.
New Mexico, 1 specimen.
New Jersey, 18 specimens.
New York, 23 specimens.
North Carolina, 12 specimens.
Ohio, 1 specimen.
Oregon, 7 specimens.
Pennsylvania, 10 specimens.
Sonora, 6 specimens.
Tennessee, 9 specimens.
Texas, 24 specimens.
Utah, 2 specimens.
Virginia, 8 specimens.
Washington, 13 specimens.
Wyoming, 8 specimens.

In addition to the specimens examined, much information has been gathered from the literature of the subject, and some from unpublished sources, derived from correspondence, particularly in regard to Texas, California and Arizona.

The large amount of material thus brought together has naturally been utilized incidentally for other purposes than that of its bearing on the relationship of *C. auratus* and *C. cafer*, since it afforded exceptionally favorable opportunities for studying the characters of the several forms in their first or nestling plumages, as well as in respect to seasonal, individual and geographical variation. Consequently, a few paragraphs are devoted in the present paper to each of these subjects. Mr. Frank M. Chapman, Assistant Curator in this department, has also further utilized this material as the basis of his paper 'On the Color-Pattern of the Upper Tail-Coverts in *Colaptes auratus*,' recently published in this Bulletin.[1]

I.—The Relationships of *Colaptes auratus* and *C. cafer*.

In 1858 Professor Baird, in his Report on North American Birds,[2] first called attention to the unique and since then notorious case of *C. auratus* and *C. cafer* (or *C. mexicanus*, as then designated), as presented by a large series of specimens from the region of the Upper Missouri and Yellowstone Rivers, in which the characters of the two birds were combined in a constantly varying and often asymmetrical manner. His material enabled him to present very fully the leading facts of the case, and led him to conclude that the state of affairs thus revealed pointed clearly to hybridization on a grand scale between the two species

[1] Vol. III, No. 2, Art. XXI, pp. 311–314, Aug., 1891.
[2] P. R. R. Expl. and Surv., Vol. IX, pp. 122–124.

in question, notwithstanding the startling nature of such an assumption. While he named the variously intermediate birds *Colaptes hybridus*, he distinctly stated that the name was not given in a specific sense, but merely for the convenient designation of the intermediate birds. Under this name they were currently known in literature for the next quarter of a century. For a time Professor Baird's explanation of the case was very generally accepted as probably correct, but later other hypotheses were suggested. Thus, in 1872, when the distribution of the so-called 'hybrids' was supposed to cover a much smaller area than the examination of the present available material shows to be the case, it was argued that the peculiar intergradation between these two forms might be due to the action of environment,[1] in accordance with certain well-established laws of geographic variation affecting many other species having a somewhat similar distribution. This suggestion met with sufficient favor to render for a time the question at least an open one.[2]

In 1877 it was suggested that these intermediate birds might be "remnants of a generalized form from which two 'incipient species' have become differentiated," and that "this 'hybrid' series is gradually losing its neutral character through the nearer approach, generation by generation, of its members to the characters of one or the other of the two specialized forms."[3] In 1884 it was suggested that the so-called hybrids, or birds of mixed character, may constitute "perhaps....a hybrid, and perhaps....a transitional form."[4]

The most recent writer on the subject treats the intermediate birds as a "race," with the nomenclatural status of a species, under the name *Colaptes ayresi*,[5] which is only an earlier name for Baird's *C. hybridus*. While admitting that this 'race' was "produced originally by the union of *C. auratus* and *C. mexicanus*" (=*cafer*), the suggestion is made that these intermediate birds may be, in some cases, "a sign of reversion to a remote ancestral plumage."[6]

[1] *Cf.* Allen, Bull. Mus. Comp. Zoöl., III, No. 6, 1872, pp. 118, 119.
[2] *Cf.* Coues, Birds of the Northwest, 1874, p. 293.
[3] Ridgway, Orn. 40th Parallel, 1877, p. 556.
[4] Coues, Key to N. Am. Bds., revised ed., 1884, p. 492.
[5] A name given by Audubon in 1843 to mixed birds from the Upper Missouri country.
[6] Hargitt, Cat. Bds. Brit. Mus., XVIII, 1890, p. 8.

Before proceeding further, it may be well to consider briefly the distinctive characters and the geographical distribution of each of the several North American forms of the genus *Colaptes*. Beginning at the southward, we have first *C. mexicanoides*, restricted, so far as now known, to Guatemala,[1] but possibly ranging northward to the southern border of Mexico. This is essentially *C. cafer* with the coloration intensified, the black cross-bars of the whole dorsal plumage being broadened, the white rump more or less spotted with black, the entire top of the head and nape rufous instead of cinnamon, and the quills and malar stripe a deeper, darker red. Whether the habitats of *C. mexicanoides* and *C. cafer* actually meet, and whether or not the two forms intergrade, lack of material leaves us in doubt, the region where this should occur, if actually taking place, being unrepresented in the material at hand. The most southern specimens of *C. cafer*, however, tend decidedly toward *C. mexicanoides*, and one example, from Mirador (U. S. Nat. Mus., No. 42,065), may be regarded as a good intermediate, being nearly as much like the one as the other. Allowing the sum of the characters of *C. mexicanoides* to be represented by 100, 80 per cent. of them may be considered as common also to *C. cafer*, as this form is represented in Mexico, with a probability of complete intergradation, since the differences separating them are wholly differences of degree.

The habitat of *C. cafer*, in considering the relation of this form to its northern congeners, is of special interest. *C. cafer* is found from the southern border of Mexico northward throughout Mexico, excepting western Sonora and Lower California, and thence northward over the western part of the United States and British America, from about the eastern base of the Rocky Mountains to the Pacific Coast.

C. rufipileus, from Guadalupe Island, off Lower California, is an insular form of *cafer*, differing from *cafer* mainly in smaller size, much longer bill, and rather deeper colors, in this latter respect rather more resembling *C. cafer saturatior* of the Northwest Coast. It was evidently derived from Californian rather than Mexican stock.

[1] See the accompanying map.

C. cafer saturatior, from the coast region of Washington and British Columbia, is the inevitable, naturally-to-be-expected Northwest Coast form of *C. cafer*, differing from the latter in slightly larger size and much deeper colors, and passing by insensible gradations into the paler bird of the adjoining interior. Both of these forms are evidently offshoots from the pure *cafer* stock, modified by environment under the ordinary laws of geographic variation prevailing over the regions in question.

C. chrysoides is found in the peninsula of Lower California, where it is the sole representative of the genus; it also ranges into Sonora, and thence northward into southern Arizona and southeastern California. To the northward and eastward its habitat thus reaches, and at some points (at least in winter) overlaps that of *C. cafer*, with which, however, it appears never to blend. At least a large series of Arizona specimens of both species presents no intermediates. While it would be rash to assert that the two forms will not be found to interbreed in Sonora, where for a long distance their ranges must adjoin, and whence as yet material is lacking, I believe that the few intermediates hitherto doubtfully supposed to exist will prove to be *cafer* + *auratus*, wrongly identified as *cafer* + *chrysoides*. In *C. chrysoides* we have, as regards general characters, a small, pale form presenting the general appearance of *mexicanoides*, it being rather nearer this species in the aggregate of its characters than it is to *cafer*; it differs from either, however, in one very radical feature of coloration, namely, in the quills being golden, as in *auratus*, instead of red, as in the *cafer-mexicanoides* group. Yet the golden quills are the only color feature which in any way recalls *auratus*, and hence does not necessarily imply any close genetic relationship between *chrysoides* and *auratus*. Besides, in the large series of *chrysoides* examined there is no trace of any of the distinctive features of *auratus*, such as the red nuchal crescent, the black malar stripes, or the peculiar coloration of the head. If we let the sum of the characters of any form of *Colaptes* be represented by six, five of the characters of *C. chrysoides* would be shared in common with the *cafer-mexicanoides* group and one only by *auratus*.

C. auratus, while ranging over the northern and eastern three-fourths of the continent of North America, has also two outlying insular forms, *C. chrysocaulosus* of Cuba, and *C. gundlachi* of Grand Cayman, both evidently offshoots from the *auratus* stock, modified by environment, and differing from *auratus* somewhat as *mexicanoides* differs from *cafer*.

The species of *Colaptes* found north of the Isthmus of Panama thus fall into three groups, two of which are much more closely related to each other than either of these two is to the third. These are (1) the *cafer-mexicanoides* group, (2) the *chrysoides* group, (3) the *auratus* group. The first and the last, so far as features of coloration are concerned, are the most unlike, having no special characters in common, and yet it is these two, *cafer* and *auratus*, which, as shown by the material now in hand, thoroughly intergrade wherever their habitats meet, that is, over a belt of country from 300 to 400 miles wide, and some 1200 to 1500 miles long. They are also more or less mixed from the eastern border of the Great Plains westward to the Pacific Coast, from about the latitude of 38° northward to about latitude 55°.

The leading distinctive characters of *C. auratus*, as compared with *C. cafer*, are:

Auratus.	*Cafer.*
1. Quills *yellow*.	Quills *red*.
2. Male with a *black* malar stripe.	Male with a *red* malar stripe.
3. Adult female with *no* malar stripe.	Adult female with (usually) a distinct *brown* malar stripe.
4. *A scarlet nuchal crescent in both sexes.*	*No nuchal crescent in either sex.*
5. Throat and fore neck *brown*.	Throat and fore neck *gray*.
6. Whole top of head and hind neck *gray*.	Whole top of head and hind neck *brown*.
7. General plumage with an *olivaceous* cast.	General plumage with a *rufescent* cast.

Characters shared in common by both are:

1. General size.
2. Proportion of parts.
3. General pattern of coloration.
4. Habits.
5. Notes.

In size, in the general pattern of the coloration, in habits and notes, the two species are indistinguishable.

The presence of a nuchal crescent in both sexes in the one and its absence in the other, the striking contrast in the color of the malar stripes, and of the quills of the wings and tail, and the transposition of the colors of the crown and throat, are, however, not simply differences of degree, but of a radical nature. In fact, no two congeneric species could well present more striking differences as regards coloration.

The manner of the interblending of the characters of the two species in the mixed birds has an important bearing upon the problem of the relationship of the two birds, as regards (1) the way in which the characters of the two species are combined, and (2) the geographical area over which the mixed birds are distributed.

HOW THE CHARACTERS OF THE TWO SPECIES ARE COMBINED.—As has been long known—indeed, as shown by Baird in 1858—the 'intermediates' or 'hybrids' present ever-varying combinations of the characters of the two birds, from individuals of *C. auratus* presenting only the slightest traces of the characters of *C. cafer*, or, conversely—individuals of *C. cafer* presenting only the slightest traces of the characters of *C. auratus*—to birds in which the characters of the two are about equally blended. Thus we may have *C. auratus* with merely a few red feathers in the black malar stripe, or with the quills merely slightly flushed with orange, or *C. cafer* with either merely a few black feathers in the red malar stripe, or a few red feathers at the sides of the nape, or an incipient, barely traceable scarlet nuchal crescent. Where the blending of the characters is more strongly marked, the quills may be orange yellow or orange red, or of any shade between yellow and red, with the other features of the two birds about equally blended. But such examples are exceptional, an unsymmetrical blending being the rule, the two sides of the same bird being often unlike. The quills of the tail, for example, may be part red and part yellow, the number of yellow or red feathers varying in different individuals, and very often in the opposite sides of the tail in the same bird. The same irregularity occurs also, but apparently less frequently, in the quills of the wings. In such cases the quills may be mostly yellow with a few red or orange quills intermixed, or red with a similar mixture of yellow. A bird may have the general coloration of true *cafer* combined with a well-developed nuchal crescent, or nearly pure *auratus* with the red malar stripes of *cafer*. Sometimes the body plumage is that of *C. auratus* with the head nearly as in pure *cafer*, or exactly the reverse may occur. Or we may have the general plumage as in *cafer* with the throat and crown as in *auratus*, and the malar stripe either red or black, or mixed red and black, and so on in almost endless variations, it being rare to find, even in birds from the same nest, two individuals alike in all their features of coloration. Usually the first trace of *cafer* seen in *auratus* manifests itself as a mixture of red in the black malar stripe, either as a few red feathers, or as a tipping of the black feathers with red, or with merely the basal portion of the feathers red. Sometimes, however, there is a mixture of orange or reddish quills, while the malar stripe remains normal. In *C. cafer* the traces of *auratus* are usually shown by a tendency to an incipient nuchal crescent, represented often by merely a few red-tipped feathers on the sides of the nape; at other times by a slight mixture of black in the red malar stripe.

THE GEOGRAPHICAL AREA OVER WHICH THE MIXED BIRDS ARE DISTRIBUTED.—In 1858, when Baird described his *Colaptes hybridus*, and for many years after, mixed birds were known only from the upper Missouri and Yellowstone region. Later they were noted from California, and more recently from various points along the western border of the Great Plains, from Texas northward to the British boundary.

Occasional specimens of *C. auratus* from the Atlantic States, showing a few red feathers in the malar stripe, have also been for some time known, but the occurrence of a large proportion of mixed birds in California has only lately been recorded. Yet the distribution of mixed birds, as shown by the material now brought together,[1] proves to be far more extended and general than till now has been supposed. Instead of the mixed birds being comparatively limited in distribution, they are found to have a wide dispersion, occurring, as already stated, with considerable frequency from the eastern border of the Great Plains westward to the Pacific Coast, and from near the Mexican boundary northward to some distance north of the United States, with, however, the area of greatest abundance much more local-

[1] See the accompanying map.

ized. No mixed birds, however, have been seen from any part of Mexico, nor from any part of Arctic America, where in the one case only pure *cafer* is found, and in the other only pure *auratus*.

East of the Mississippi River, from Florida northward and westward to Alaska, *C. auratus* rarely shows any outcropping of the characters of *C. cafer*. Perhaps one male in a thousand (or more probably a still smaller proportion) shows a few red feathers in the malar stripe, varying in different individuals from the faintest perceptable trace to a mixture of one-fourth to one-third red. A single bird from Louisiana (Coll. Gustave Kohn) has the malar stripe wholly red and the whole head nearly as in *cafer*, and a single specimen from Toronto, Canada (Coll. E. E. Thompson, No. 206[1]) has the tail about half orange red, with other traces of *cafer* characters ; and I have heard of what purports to be the capture of a nearly pure *cafer* specimen in Pennsylvania, but this latter case is not well authenticated. Specimens with a slight amount of red in the malar stripe are represented in the material I have examined from Massachusetts, Long Island, New Jersey (five specimens), Pennsylvania, Virginia, Florida (several), Louisiana (several), Tennessee, Ohio, Indiana, Illinois (several), Michigan (two), and Minnesota. They seem to be quite as frequent along the Atlantic seaboard as at any point east of the Mississippi River. Material from the States immediately west of this line, from Iowa southward, is scanty, but the few specimens seen do not indicate a larger proportion of birds with red in the malar stripe than occur in Florida or New Jersey. It is hence probable that nearly pure *auratus* prevails westward to the eastern border of Texas, the Indian Territory, Kansas, and Nebraska, and over the greater part of both Dakotas and Manitoba. Birds from eastern Texas, eastern Kansas, and eastern Montana, taken in the breeding season, generally, or at least frequently, show some traces of the characters of *cafer*, the malar stripe frequently being more or less mixed with red. In southeastern Texas, and thence northward through middle Texas, and over the Plains to, and doubtless much beyond, the northern boundary of Montana, mixed birds are the rule, the characters of the two species being blended in every conceivable combination, pure *cafer* or pure

[1] See Auk, Vol. II, 1885, p. 335.

auratus being rarely met with, except in winter, when, in consequence of migration, pure *auratus* is more or less frequent in Kansas, the Indian Territory, and Texas, considerably to the westward of its normal limit in the breeding season.[1] At the same time there is an influx into the same region of nearly pure *cafer* from the westward, resulting in a commingling of birds presenting mixed characters with those of normal character.

In western Texas, New Mexico, Arizona, and southern California, the prevailing form in the breeding season is probably nearly pure *cafer*, but in winter the proportion of perfectly pure birds is much smaller, owing to the southward migration of slightly-mixed birds from further north. In a series of over 30 males from Arizona, taken between October 1 and March 30, more than one-third show either traces of black in the malar stripe, or traces of a scarlet nuchal crescent, or both. One female has all the quills orange yellow, but generally the equally large series of females shows no recognizable characters of *auratus*.

In central and western Colorado, Utah, and Nevada, the characters of *cafer* evidently prevail, at least in the breeding season; in eastern Colorado in winter and during migrations mixed birds are the more common, and have been taken in the breeding season at Fort Garland in the same State. Similar specimens have been taken in Utah and Nevada, every one of my series of seven males from Nevada showing traces of the red nuchal crescent, and some of them other characters of *auratus*.

Of Idaho almost nothing is known. The single specimen I have seen is a mixed bird. In Wyoming mixed birds appear to be the rule, with *auratus* characters prevailing in the eastern part of the State and *cafer* characters in the western. The same is apparently true of Montana. Birds from eastern Oregon, eastern Washington, and eastern British Columbia, or from the area east of the Cascades, also present a strong infusion of *auratus* characters; some specimens being two-thirds to three-fourths *auratus* and others nearly pure *cafer*, with rarely a normal bird of either species. The bird of the coast region, from the mouth of the

[1] Mr. H. P. Attwater writes me that at San Antonio "Typical *auratus* is common in winter; the bulk migrate earlier than *C. cafer*. Typical *cafer* is rare; hybrid Flickers of several shades are common. All the forms have been observed migrating together."

Columbia River northward, is *C. cafer saturatior*, but a large proportion of the specimens, even from Puget Sound and Vancouver Island, show traces of *auratus* characters, in some instances very prominent traces, even to yellow quills interspersed with red ones. Indeed, Mr. Fannin states that true *C. auratus* occurs as a rare visitor on Vancouver Island and the adjoining mainland.[1]

In central and northern California the two forms are as thoroughly mixed as at any point east of the Rocky Mountains, both *auratus* and *cafer* occurring in a nearly pure state, with birds presenting every possible combination of the characters of both species. Of 40 specimens from central California, chiefly from Marin and adjoining counties, three are nearly pure *auratus*, the only feature of *cafer* being a very slight mixture of red in the malar stripe—not more than occasionally occurs in birds from the Atlantic States ; six (of which four are females, and hence have less significance) are apparently pure *cafer;* of the remaining 31 *auratus* characters prevail in eight, and *cafer* characters in twenty, with three in which the *cafer* and *auratus* characters are about evenly divided. In San Bernardino, San Diego, and adjoining counties in southern California (I have one specimen of pure *auratus* from Warm Springs) traces of *auratus* characters are rare, while in Oregon, so far as material shows, about the same conditions of mixture occur as are found in central California. Indeed, as most of the California specimens before me were taken either in the autumn or winter, it is fair to conclude that many of them were migrants from further north, probably from Oregon or eastern Washington, since more or less mixed birds occur as far north as Sitka, and even Chilkat. Beyond this point, to the northward and eastward, *cafer* appears to be replaced by pure *auratus*, from which region, through migrants, is doubtless derived the strong infusion of *auratus* characters in the birds of California.

To summarize the foregoing, we find that *cafer* unmixed with *auratus* occupies Mexico, but that very soon after crossing the United States boundary we begin to meet with specimens showing slight traces of the characters of *auratus*, and that as we proceed northward these traces become more frequent and more

[1] Check List of British Columbia Birds, 1891, p. 29.

pronounced, across the whole breadth of the habitat of *cafer*, till north of the United States we pass into the habitat of pure *auratus*. There is also the same blending in passing eastward from the eastern base of the main chain of the Rocky Mountains. Thus the blending is complete along the line of junction of the habitat of the two species, or from southeastern Texas northward along the western edge of the Plains into British America and thence westward in British America to the Pacific Coast in southern Alaska. From this line we may trace the mixed birds westward and southward over nearly the whole range of *cafer* north of Mexico, due apparently from not only the mixing of the two species wherever their habitats adjoin, but through the intrusion, mainly from the northward, of *auratus* into the habitat of *cafer* through the southward migration of *auratus* in winter, some of the latter apparently remaining as summer stragglers to breed.

The conditions here outlined are shown graphically on the accompanying map, compiled primarily from specimens actually examined by the writer, but supplemented to a considerable extent by an examination of the available literature bearing on the subject. An attempt is made to distinguish by the use of different symbols, in the case of not only *C. auratus* and *C. cafer*, but of the intergrades as well, the nature of the record as regards season, as explained on the map itself. The boundary lines are of course to some extent hypothetical.[1]

Conclusions.—The facts elicited in the present investigation tend strongly to confirm Baird's startling hypotheses of hybridization on a grand scale between *Colaptes auratus* and *C. cafer* to account for the occurrence of birds presenting ever-varying combinations of the characters of the two species over the Plateau and Great Basin regions of the continent. None of the other hypotheses thus far advanced so fully, or in fact to any great extent, meet the requirements of the case. In no instance do we meet with stages or methods of geographical variation at all comparable with what is seen in the case of *C. auratus* and *C. cafer*.

[1] The habitats of *C. chrysoides* and *C. cafer* overlap; the lighter line is intended to indicate the northern and eastern boundary of that of the former, the heavy line the southwestern boundary of that of *cafer*.

The transition between geographic forms, however diverse, is gradual and symmetrical, affecting all parts of the plumage equally and simultaneously, and is obviously correlated with changes in the physical surroundings; also the differences between the most extreme forms are merely differences of degree. In the case of *Colaptes* the essential differences between *auratus* and *cafer* are radical; they are, in fact, contrasting characters; and the intergradation is irregular, with all sorts of asymmetrical combinations of the characters of the two forms, and no correlation between their intergradation and the conditions of environment.

In California, British Columbia, Montana, Wyoming, Kansas, and southern Texas, we get the same irregular and multifarious combinations of the characters of the two species. On the other hand, the phenomena of intergradation, as regards both the nature of the intergrades and their geographical distribution, are just what we should expect them to be on the theory of interbreeding. Furthermore, it is a matter of observation that very unlike birds pair together, and that individuals of the same brood are often very diverse in appearance. While I know of no record of pure *cafer* birds being found mated with pure *auratus* birds, that such mating has many times occurred seems beyond question, since this might happen at any point along a line more than a thousand miles in extent where the habitats of the two species adjoin. On either side of this boundary the influence of one species upon the other fades out gradually as the distance from the line increases, till in Mexico, in the United States east of the Mississippi River, and in Alaska and eastern British America, it becomes practically *nil.* The outcropping of *auratus* characters in *cafer* in British Columbia and in the United States west of the Rocky Mountains, and the gradual fading out of this infusion to the southward, can readily be accounted for by the migration of *auratus* from the north into the northern border of the habitat of *cafer*, and the gradual wide dispersion southward of the intermediates resulting from the interbreeding of the two species. The very slight traces of *cafer* characters occurring in rare instances in *auratus* in the East may be readily supposed to be due to the sporadic dispersion eastward of waifs from the habitat of *cafer*, since it is known that nearly all western birds occasionally stray eastward even to the Atlantic seaboard. The capture near New Orleans and Toronto of strongly marked 'hybrids' shows that at least 'intermediates,' if not representatives of pure *cafer*, stray far to the eastward of their proper habitat.

It is thus unnecessary to suppose that the appearance of a few red feathers in the malar stripe of specimens of *auratus* taken in the Atlantic States indicates a tendency to a reversion to some hypothetical 'ancestral type' which had the malar stripe red, or that the presence of black feathers in the malar stripe, or an incipient scarlet nuchal crescent, in birds from Arizona, Nevada, and southern California, indicates a similar tendency to a hypothetical ancestor which had black malar stripes and a red nuchal crescent; since the slight infusion of *cafer* blood in the one case, and of *auratus* blood in the other, of which we have almost indubitable proof, affords an adequate and satisfactory explanation of these odd phenomena.

The large infusion of *auratus* blood shown in the *Colaptes* stock in Oregon and northern California is easily explained by the fact that *C. auratus*, like many other eastern birds, can find easy access to the northwest coast either by way of the low divide in Wyoming, or from the northward, the habitat of *auratus* reaching the Pacific Coast in northern British Columbia and Alaska.

It is of interest in this connection to note that in the earlier collections from California 'hybrid' Flickers were practically unknown, there being none in the material handled by Baird in 1858. In 1870 Dr. J. G. Cooper considered the capture of two examples of *Colaptes*, taken at Oakland, presenting characters of *auratus*, worthy of special record.[1] But Mr. W. E. Bryant, in Belding's 'Land Birds of the Pacific District,' published in 1890, says that specimens referable to '*hybridus*' "are now taken almost as often as *C. cafer*; in fact, it is unusual to get really good examples of *C. cafer* in some localities" (l. c., p. 72). My own series from central and northern California, as already noted, fully bears out this statement. In our standard works on North American birds, even in the latest, the habitat of the so-called '*hybridus*' is given as the region of the upper Missouri and

[1] Orn. Cal., I, p. 412.

Yellowstone and the Black Hills. Now, however, we have evidence of the occurrence of mongrel birds in abundance over a belt of country, hundreds of miles wide, extending from the Rio Grande in Texas northward and westward to southern Alaska. Hence one may almost ask whether this does not favor the assumption that *C. auratus* is gradually extending its range into the habitat of *C. cafer*, particularly in California, and along the whole border of the habitat of *cafer*. Unfortunately the evidence favoring this assumption is mainly negative, owing to the deficiency of material from the habitat of *cafer* collected prior to a comparatively recent period.

Finally, it may be added, the intergradation between *Colaptes auratus* and *C. cafer* is not only unique as regards the character and geographical distribution of the intergrades, but is something superimposed upon ordinary geographic variation due to environment, since the ordinary phases of geographic variation, as seen in other birds having the same distribution, is well illustrated in the various North American forms of *Colaptes*, as has already been indicated, and as will be presently shown more in detail.

II.—Geographical Variation.

(1) In Size.—In both *Colaptes auratus* and *C. cafer* there is a marked decrease in size from the north southward.

The average length of the wing in specimens of *C. auratus* from Arctic America is 6.35 in.; in specimens from South Florida, 5.75 in., giving an average difference of .60 of an inch between birds from the extreme north and the extreme south—equal to rather more than 10 per cent. of the average length of the wing in the southern birds. Specimens from near the northern boundary of the United States, from New England and New York westward to Minnesota, are just intermediate in size between the specimens from Arctic America and South Florida, the average length of the wing being 6.12.

The Cuban *Colaptes chrysocaulosus* is still smaller than the Florida birds (wing about 5.55), while *C. gundlachi* from Grand Cayman, is slightly smaller than the Cuban form.

In *C. cafer* geographical variation in size is less uniform, in passing from the north southward, specimens from Chihuahua and Arizona being nearly as large as specimens from Montana and British Columbia, the difference in latitude perhaps being partly offset by the greater elevation of the more southern region. Specimens from southern Mexico, however, are much smaller than those from Chihuahua and Arizona, the wing in eight males averaging 6.07.

C. cafer saturatior, from the Northwest Coast, has the average length of the wing about 6.55, while in *C. rufipileus*, from Guadalupe Island, it is about 5.93, or about the same as in specimens from southern Mexico—a difference nearly parallel with that between *C. auratus* from Arctic America and Florida.

C. mexicanoides averages only a little smaller than examples of *C. cafer* from southern Mexico, the former having the wing 6.10, the latter about 6.50.

C. chrysoides presents great constancy in size, there being no very appreciable difference in this respect between specimens from Arizona and the southern part of the peninsular of Lower California. The length of the wing averages about 5.75—the same as in South Florida examples of *C. auratus*, and hence less than in any of the forms of the *C. cafer-mexicanoides* group.

The accompanying table of measurements (see p. 38) shows[1] more in detail the variation in size with locality here summarized.

(2) In Coloration.—The geographical variation in coloration in the various forms of *Colaptes* is quite parallel to that in other species of similar distribution, and hence presents nothing especially noteworthy. In *C. auratus* there is a lightening of the colors as we approach the Plains. This is very noticeable even in Minnesota specimens, and still more so in specimens from the Dakotas, Nebraska and Kansas.

It has been suggested that the resident form of South Florida would prove separable as a subspecies from the bird found at large further north, on the basis of its smaller size and darker colors. The average difference, however, as shown by a large

[1] These measurements have been made with great care by Mr. C. B. Isham, an assistant in this department of the Museum, and are hence all strictly comparable with each other.

TABLE SHOWING GEOGRAPHICAL AND INDIVIDUAL VARIATION IN SIZE IN THE NORTH AMERICAN SPECIES OF *Colaptes*.

SPECIES.	LOCALITY.	No. of Specimens.	Sex.	WING.			TAIL.			CULMEN.		
				Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
C. auratus	Arctic America	8	♂	6.37	6.62	6.20	4.26	4.56	4.06	1.44	1.58	1.36
" "	" "	6	♀	6.32	6.50	6.18	4.25	4.34	4.14	1.36	1.52	1.31
" "	Northern United States	19	♂	6.15	6.40	5.94	4.09	4.52	3.90	1.40	1.54	1.26
" "	" " "	18	♀	6.08	6.30	5.80	4.01	4.40	3.70	1.32	1.52	1.16
" "	Florida	10	♂	5.77	5.92	5.66	3.89	4.10	3.70	1.33	1.38	1.24
" "	"	10	♀	5.72	6.08	5.42	3.81	4.24	3.76	1.29	1.40	1.12
C. chrysocaulosus	Cuba	2	♂	5.67	5.68	5.67	4.19	4.20	4.18	1.35	1.36	1.34
" "	"	8	♀	5.47	5.66	5.32	4.15	4.34	4.00	1.32	1.38	1.26
C. cafer	Arizona	10	♂	6.53	6.70	6.36	4.45	4.78	4.20	1.43	1.48	1.40
" "	"	10	♀	6.41	6.72	6.20	4.23	4.42	4.04	1.40	1.46	1.32
" "	Chihuahua	10	♂	6.52	6.70	6.30	4.22	4.52	3.96	1.50	1.62	1.38
" "	"	10	♀	6.46	6.72	6.18	4.34	4.62	3.96	1.49	1.62	1.36
" "	Southern Mexico	7	♂	6.07	6.52	5.92	4.71	4.86	4.45	1.40	1.45	1.30
C. cafer saturatior	Brit. Col. and Washington	10	♂	6.55	6.64	6.46	4.56	4.86	4.10	1.56	1.66	1.48
" " "	" "	10	♀	6.51	6.82	6.36	4.53	4.84	4.16	1.47	1.56	1.40
C. rufipileus	Guadalupe Island	1	♂	5.94	....	....	4.16	....	....	1.58		
" "	"	4	♀	5.92	6.20	5.76	4.40	4.50	4.34	1.49	1.60	1.40
C. mexicanoides	Guatemala	6	♂	6.11	6.24	6.00	4.40	4.50	4.34	1.49	1.60	1.40
" "	"	4	♀	5.96	6.00	5.92	4.27	4.38	4.18	1.39	1.40	1.36
C. chrysoides	Arizona	8	♂	5.78	5.84	5.70	3.72	4.00	3.52	1.46	1.58	1.38
" "	"	4	♀	5.68	5.80	5.60	3.44	3.60	3.32	1.48	1.68	1.36
" "	Triumfo, L. Cal	12	♂	5.74	6.92	5.54	3.72	3.94	3.40	1.36	1.40	1.26
" "	" "	12	♀	5.64	5.80	5.42	3.65	3.82	3.34	1.34	1.46	1.26

amount of material, proves too slight and too inconstant, in either size or color, to make a separation practicable, as is readily shown by comparison of a considerable series of breeding birds from South Florida with a corresponding series from the Middle States or New England. Some of the South Florida birds are not only small, but also exceptionally dark, but the dark color proves to be due in large part to the worn condition of the plumage, consequent upon the breeding season, and in some measure to soiling of the plumage, due apparently to contact with burnt trees. Specimens nearly as dark occur, however, in New Jersey and Massachusetts, so that the average difference in color between Florida and northern birds is not readily appreciable.

C. cafer presents four geographical phases, correlated with very different climatic conditions. First, the pale form, found throughout the arid interior, from Central Mexico northward. Second, the darker, much deeper-colored Northwest Coast form, known as *C. cafer saturatior*. Third, a quite similar phase, as regards coloration, but much smaller, from southern Mexico. Fourth, the insular *C. rufipileus* from Guadalupe Island, off the coast of southern California. This closely resembles *saturatior* in color, but is much smaller and has a relatively much longer bill.

Attention has previously been called[1] to the small size of the birds from southern Mexico, and also to their resemblance in color to birds from Vancouver.[2] The specimens before me show that the birds from southern Mexico are not only much smaller than specimens from Chihuahua and Arizona, but they closely resemble in color subspecies *saturatior* from the Northwest Coast, a condition of things quite in accord with the well-known lines of geographic variation in other groups, and perhaps justifying Mr. Ridgway's suggestion (l. c.) that it may prove expedient to recognize these small, dark-colored southern birds as a geographic race.

C. mexicanoides may perhaps be almost considered as an extreme southern differentiation of *C. cafer*, in which all the

[1] Ridgway, Man. N. Am. Birds, 1887, p. 296, foot-note.
[2] Hargitt, Cat. Bds. Brit. Mus., XVIII, 1890, p. 19.

colors and markings are much stronger than in any form of the *C. cafer* group. So far as now known, however, it must take rank as a species instead of a subspecies.

III.—Individual Variation, and Variation due to Age and Season.

(1) Individual Variation.—The range of individual variation in the various North American forms of *Colaptes* is rather greater than the average range in other species, especially in respect to color. The variation in size is perhaps sufficiently shown in the table of measurements given on page 38 (compare under each species the columns headed respectively 'maximum' and 'minimum'). The bill varies in length, in the different forms, from 15 to 25 per cent. of the mean; the length of the wing, from 8 to 12 per cent.; the length of the tail, from 12 to 18 per cent. The female, judging from the measurements of about 200 specimens, is rather more variable than the male. While the female averages smaller than the male, the largest bird of a series of specimens, taken at the same locality and at the same season, proves sometimes to be a female, while some of the smallest birds of the series may be males. The tail varies more than the wing, and the bill much more even than the tail.

Individual variation in color affects (1) the size and shape of the circular black spots on the lower plumage, (2) the width and number of the dusky crossbars of the upper plumage, (3) the size and form of the malar stripe, (4) the presence or absence of black spots on the white rump, (5) the tone of color suffusing the general plumage. The last, however, is more or less complicated with seasonal variation.

The pattern of coloration being the same in all the forms, and the extent and character of the variation similar in each, the remarks here following may be understood as applying to the group collectively, unless otherwise stated.

Each feather of the ventral surface, from the pectoral crescent posteriorly, is marked near the tip with a circular spot of black; they are smaller and more nearly circular anteriorly, larger and transversely broader posteriorly. Those of the breast vary greatly in size and shape in different birds, being sometimes round, sometimes pear-shaped, sometimes transversely oval, and sometimes longitudinally oval. In some birds they are twice as large as in others, varying in different birds from an average diameter of 2 or 3 mm. to an average diameter of 4 or 5 mm., comparing in each case corresponding feathers.

The interscapulars, scapulars, wing-coverts and quills are barred transversely with black. These bars, usually three in number, vary enormously in width in different specimens strictly comparable as regards age, season and locality. The apical bar, for example, has usually a width of about 2½ mm.; the extremes vary from 1 to 4 mm., resulting of course in a very different general effect. Generally speaking, birds with small spots on the ventral surface have narrow bars on the dorsal surface, and conversely; but this is by no means an invariable rule, since birds occur with very large spots on the lower plumage and very narrow bars on the upper plumage, or the reverse. Extreme variations in the size of the spots and bars are especially common in both *C. chrysoides* and *C. cafer*; in *C. auratus* the range of variation is narrower and extreme departures from the normal are less frequent.

The malar stripe varies in form and extent in the male in all the forms, but more in *C. auratus* perhaps than in the others. It is sometimes very broad and at the same time very long, thus greatly exceeding the normal or average extent; sometimes it is very much reduced, occasionally to one-half, and in extreme cases to one-third the normal size. Thus the area may be two to three times greater in some specimens than in others.

There are occasionally indications of a malar stripe in the female. This, however, is very rare in *C. auratus* and *C. chrysoides*, but common in the *C. cafer* group, and the rule in *C. mexicanoides*, where the exceptions are rare. When present in the female it differs greatly in color from the corresponding mark in the male. In *C. auratus* a very small percentage of the females have the area occupied by the malar stripe in the male faintly tinged with grayish, the basal portions of the feathers being dusky and showing slightly at the surface. In one specimen (No. 8308, ♀ ad., Coll. Wm. Brewster), from Ann Arbor, Michigan, the feathers of the malar area are distinctly black beneath the surface, the black extending quite to the tips of some of the feathers, forming a well-marked incipient malar stripe. This is, however, an extreme case, and almost unique. In another specimen, also from Michigan (Ypsilanti, No. 8306, ♀ ad., Coll. Wm. Brewster), a few of the feathers of the malar region are tipped with black and many others with *red*, giving rise to a very narrow *red* malar stripe slightly mixed with black. Otherwise the bird is a normal example of *C. auratus*.

In a very large series of *C. chrysoides* two females show a faint wash of cinnamon at the posterior border of the area colored red in the male. This, however, may be due merely to immaturity, the birds being apparently young of the year, in which a slight trace of the brownish malar stripe is usually present in the female prior to the first molt.

In all the forms of *C. cafer* the adult female has generally an incipient brownish cinnamon malar stripe, sometimes as well defined as is the red malar stripe in the male. In perhaps ten to twenty per cent. of the birds examined it is entirely wanting; in a large proportion it is clearly outlined, but the brownish tint is superficial and more or less mixed with gray; in fully one-third, however, it is as distinct as in the female of *C. mexicanoides*, and nearly as bright in color, being of the same rich cinnamon rufous as the forehead and the superciliary stripe. These variations have evidently no geographical significance, since the whole range of variation here indicated occurs in birds from Montana, British Columbia, Washington, California, Arizona, and Mexico, with the several phases similarly represented at each of these localities.

As regards the tone of color suffusing the general plumage, fall birds from the same locality show a wide range, whatever the species may be, and the same is true of breeding birds. In *C. auratus*, for example, the ground color of the back varies, in fall birds, from hair brown through olive to bistre (*cf.* Ridgway, Nomen. Colors), while the lower surface varies from a strong tinge of yellow to tawny vinaceous. In spring birds the lower surface varies from nearly white to dull vinaceous cinnamon, with a corresponding range of variation in the dorsal plumage.

A male example of *C. cafer saturatior* (No. 1160, Coll. Prof. J. Macoun, Burrard Inlet, B. C., April 29, 1887,) is noteworthy on account of having a distinct but narrow supraloral line of *bright red* on each side, meeting in front across the base of the forehead.

(2) SEASONAL VARIATION.—The purely seasonal variation in color results as usual from (1) fading and (2) abrasion. In fall birds the plumage is more heavily suffused with coloring matter, both above and below, and the tints are thus deeper and stronger. During winter there is a gradual loss of color, which proceeds more rapidly during the spring and early summer, simply through fading from exposure, resulting in a marked change in tone. At the same time the edges of the feathers become gradually worn away, till, towards the end of the breeding season, the light-colored apical border has disappeared. This gives greater distinctness and prominence to the black spots below and the dark bars above, which in fresh plumage are partially veiled by the overlapping lighter edges of the feathers. This, with the change in the tone of the ground color, results in a very different general effect, the breeding bird appearing blacker and more heavily spotted and barred than when in fresh autumnal or winter plumage.

Seasonal change of color, due to fading and abrasion, is in general much greater than is commonly recognized, and is a factor to be constantly borne in mind in the comparison of birds from different localities. It is not perhaps greater in *Colaptes* than in many other groups.

(3) VARIATION DUE TO AGE.—Under this head will be given simply a few notes on the first or nestling plumage. In all of the forms the young birds have the whole top of the head more or less red, as in young Woodpeckers generally, through the feathers being narrowly tipped with this color. The amount of red, or the extent of this tipping, varies greatly in different individuals of even the same brood, as does likewise the shade of red, which varies from dull reddish brown to bright brick red. As regards general coloration, the markings are coarser and heavier than in the adults, and the general effect darker.

A feature of special interest in respect to the young in nestling plumage is the variable status of the malar stripe, considered as a secondary sexual character. In *C. auratus* both sexes have the black malar stripe, which in adult birds is confined to the male. In 30 specimens, varying in age from half-grown nestlings to full-fledged birds, *not one lacks the black malar stripe*, while five of them are sexed as females by their respective collectors from anatomical examination of the specimens, and attention is called on the label, to the presence of the malar stripe. While most of the other specimens are marked as males, it is quite certain that they were thus marked on the presumption that a black malar stripe denoted a male, in the young as well as in the adult.

Of four young *C. chrysoides* in first plumage two have the malar stripe red as in the adult male, while the other two have a well-defined *rufous* malar stripe, and are sexed as females by the collector. In young *C. cafer* and *C. cafer saturatus* the sexes are similarly distinguished, the malar stripe in the males being bright red and in the females rufous—in other words, the same as in the adults.

In *C. auratus* and *C. chrysoides* of North America, and in *C. campestris* and *C. agricola* of South America, the adult female lacks the red or black malar stripe (as the case may be) present in the male, while in two other South American species (*C. pitius* and *C. cinereicapillus*) this mark is not only wanting in the female but is only imperfectly developed in the male. Consequently it would seem that, on the theory that secondary sexual characters are first acquired by the male and later transmitted, more or less modified, to the female, the presence or absence of a malar stripe in the female would prove a clue to the genetic relationship of the North American types of the genus. When, however, we find the malar stripe present in both sexes in the young and absent in the adult female, as in the case of *C. auratus*, and present as a rule in the adults of both sexes and absent in the female in first plumage, as in the *C. cafer-mexicanoides* group, this character evidently fails to be of much service as an index to the ancestral relationships of the several forms.

Article III.—DESCRIPTION OF A NEW SPECIES OF PEROGNATHUS FROM SOUTHEASTERN TEXAS.

By J. A. Allen.

During the last few months the Museum has received a large number of mammals collected in the vicinity of Brownsville, Texas, among which are numerous specimens of a small species of *Perognathus*, apparently hitherto undescribed. It is allied to *P. flavus*, but evidently quite distinct from it, and may be described as follows:

Perognathus merriami, sp. nov.

Externally of the size and general proportions of *P. flavus*, but brighter and more yellowish in coloration, the sides being strongly yellowish or golden instead of pale cinnamon.

Measurements (average of three adult specimens): Total length, 115 mm.; head and body, 60; tail, 55; hind foot, 17; ear, 4.

Skull, greatest length, 23 mm.; basilar length (occipital condyle to incisors), 16.5; greatest mastoid breadth, 12.7; least intermastoid breadth, 4; least interorbital breadth, 5.1; length of nasals, 11.5; greatest zygomatic breadth, 11.5; length of upper tooth row, 3.3; breadth of palate at posterior border, 2.8; breadth of palate at anterior border, 2.3; from hinder edge of palate to inner base of incisors, 6.6; length of lower jaw, 12.7; height at coronoid process, 4.6.

Type, No. [illegible], ♂ ad., Brownsville, Texas, Aug. 10, 1891; F. B. Armstrong.

Compared with the El Paso specimens of *P. flavus* (kindly loaned me for examination by Dr. C. H. Merriam), taken Dec. 12–14, 1889, *P. merriami* differs markedly in coloration in its generally brighter yellowish color, particularly along the sides. A comparison of the skulls reveals very marked differences, not only as regards the general form but in the relative size and form of special parts, as shown in the series of figures in Plate III. In *P. merriami* the skull is much larger and disproportionately broader in proportion to the length. The mastoids are shorter and less developed, leaving a much broader intermastoid area, with the interparietal much broader than long, instead of nearly square as in *P. flavus*. The figures represent—for purposes of comparison, and also to show individual variation—three skulls of *P. flavus*, and six skulls of *P. merriami*, as seen from above, drawn twice the natural size.

In addition to the three El Paso specimens of *P. flavus* mentioned above, I have three from North Beaver River, Indian Territory (near the northern boundary of Texas), and one from Presidio County, Texas, that seem also referable to *P. flavus*.

P. merriami is based on a series of 17 specimens from Brownsville, Texas, belonging to this Museum, while a considerable number of additional specimens have passed through my hands. They were taken at various dates covering a period of over four months (July to October, inclusive), and include young and adults. The July and August specimens are a little grayer and less fulvous than those taken late in September and October. In all the tail is naked, and the pelage coarser than in *P. flavus*.

The species is named in honor of Dr. C. Hart Merriam, Chief of the Division of Economic Ornithology and Mammalogy, U. S. Department of Agriculture.

EXPLANATION OF PLATE III.

(All the figures are twice the natural size.)

Fig. 1. *Perognathus merriami*, ♂ ad. No. $\frac{3176}{4144}$, Brownsville, Tex., Aug. 4, 1891.
" 2. " " ♂ ad. No. $\frac{3177}{4145}$, Aug. 10, 1891.
" 3. " " ♀ ad. No. $\frac{3178}{4146}$, Sept. 10, 1891.
" 4. " " ♂ ad. No. $\frac{3179}{4147}$, Sept. 6, 1891.
" 5. " " ♂ ad. No. $\frac{3180}{4148}$, Sept. 13, 1891.
" 6. " " ♀ ad. No. $\frac{3181}{4149}$, Oct. 9, 1891.
" 7. *Perognathus flavus*, No. 2357, Coll. Dr. Merriam, El Paso, Texas.
" 8. " " ♀ No. $\frac{18180}{25028}$, U. S. Nat. Mus., El Paso, Texas, Dec. 14, 1889.
9. " " ♂ ad. No. $\frac{18181}{25029}$, U. S. Nat. Mus., El Paso, Texas, Dec. 12, 1889.

Article IV.—ON A SMALL COLLECTION OF MAMMALS FROM THE GALAPAGOS ISLANDS, COLLECTED BY DR. G. BAUR.

By J. A. Allen.

Dr. G. Baur, of Clark University, Worcester, Mass., has kindly placed in my hands for identification and description, the small collection of mammals recently obtained by him on the Salisbury Expedition to the Galapagos Islands. The collection numbers 12 specimens, representing 4 species. Two prove to be introduced species of *Mus*, while one is a Bat of the genus *Atalapha*, and the other a species of *Oryzomys*, allied to *O. galapagoensis* (Waterh.).

Atalapha brachyotis, sp. nov.

Apparently similar to *Atalapha varia* (Poeppig) from Chili, but rather smaller, with disproportionately smaller ears, and shorter thumb.

General color above reddish chestnut, the hairs plumbeous at base, broadly ringed subapically with yellowish rufous and tipped with chestnut, much darker on the lower back and tail; below blackish with the tips of the hairs ashy. Ears small, rounded, blackish, as also the lips. Wing and interfemoral membranes black, as are also the fingers. Posterior half of the interfemoral membrane very thinly haired.

Measurements.—Head and body, 47 mm.; tail, 44.5; ear, 7.6; tragus, 4.3; forearm, 39; thumb, 6.4; second finger (matacarpal), 42; third finger (metacarpal, 43.2, 1st phal., 16, 2d phal., 16.7, 3d phal., 3=) 79; fourth finger, 63; fifth finger, 53; tibia, 20; foot, 8.4.

Based on a single specimen in alcohol, collected on Chatham Island, June 23, 1891.

As nearly as can be judged, this insular form closely resembles *A. varia* in coloration, size and proportions, except that it has much smaller ears. The hariness of the interfemoral membrane is apparently similar in both, in *A. brachyotis* there being only a few short hairs beyond the basal half.

Compared with *A. noveboracensis* of North America, aside from the striking color differences, *A. brachyotis* is a much slenderer form; while the linear measurements are about the same, the body is much smaller, and the wing bones much more slender. There is also a marked difference in the dentition, which is very much slighter, notably shown in the size of the canines, which in *A. brachyotis* are only about half as large as in *A. noveboracensis*.

Dr. Baur writes me: "On Chatham Island, at an elevation of about 1700 feet, where the hacienda is placed, we observed bats nearly every evening, but were for a long time unable to kill a specimen; the one I send, the only one collected, was shot by Mr. Adams.

"Bats have been observed on Indefatiguable Island by Dr. Habel, and I observed one on South Albemarle."

Mus decumanus *Pall.*

Mus jacobiæ WATERH, Zool. Voy. Beagle, I, pt. ii, 1840, p. 34.

I refer to this species a mummified specimen, "found dead on Albemarle Island, opposite Crowley Island, Aug. 9, 1891." It is an adult, and measures as follows: Head and body, 190 mm.; tail, 203; hind foot, 34. Above the general color is yellowish chestnut, profusely mixed with longer wholly black hairs, passing into yellowish brown on the sides; below buffy white at the surface, the hairs from near the tips to the base pale sulphery white.

This seems to be the form collected by Darwin (op. cit.) on James Island, where he found it very common, but he does not appear to have actually met with it at any of the other islands.

Mus rattus *Linn.*

Represented by one specimen in alcohol, about two-thirds grown, apparently not distinguishable from an ordinary black rat of corresponding age. It was taken on South Albemarle, July 29, 1891.

I also refer provisionally to this species an imperfect skeleton found on Duncan Island. This specimen consists of the skull and anterior half of the spinal column, of a full-grown but not aged individual, agreeing in size with *Mus rattus*.

Oryzomys bauri, sp. nov.

Evidently allied to *Oryzomys galapagoensis* (Waterh.), but differing from it in proportions and coloration.

Pelage full and long. General color above dusky grayish brown, faintly varied with pale yellowish brown; below the pelage is white at the surface, passing into plumbeous. Muzzle lighter and more grayish, tinged strongly with yellowish brown on the sides of the muzzle and faintly so on the chin. Ears large, obtusely rounded, almost naked within, well haired externally on the anterior third, and sparsely haired over the rest of the outer surface. Feet above thinly haired, white faintly tinged with yellowish; soles naked, 6-tuberculate; posteriorly smooth and pale horn color, anteriorly granulated and yellowish, slightly varied with gray. Tail indistinctly bicolor, nearly naked, the annulations showing distinctly through the very short hairs; above dusky brown, below ashy brown.

Measurements.—Male Adult: Total length, 280 mm.; head and body, 132; tail, 147; hind foot, 32.5; fore foot, 18; ear, 18. *Female Adult:* Total length, 269; head and body, 124; tail, 145; hind foot, 31; fore foot, 16.5; ear, 17.3. *Young Male:* Total length, 248; head and body, 108; tail, 138; hind foot, 16.5; fore foot, 14.5; ear, 16.5.

Skull, ♂ ad.: Total length, 37.4; basal length (condyles to incisors), 27.5; greatest zygomatic breadth, 18.3; least interobital breadth, 5.6; length of nasals, 13.5; from posterior border of palate to incisors, 14.7; length of lower jaw (tip of incisors to condyle), 22.8; height at condyle, 9.9.

Based on 5 specimens in alcohol, namely, 1 male adult, 1 male two-thirds grown, 1 male half grown, 1 female adult, and 1 female about half grown, taken on Barrington Island, July 9 and 10, 1891. There are also three inverted skins in antiseptic solution, taken at the same place and time. The adult male may be considered as the type.

This species is apparently nearly allied to *O. galapagoensis*, described by Waterhouse from specimens collected by Darwin on Chatham Island, about thirty miles east of Barrington Island. While of about the same size as *O. galapagoensis*, it has larger ears, and the tail is half an inch or more longer than the head and body instead of being an inch or more shorter, as in *O. galapagoensis*. In coloration it is evidently much less varied with yellow, as in *O. galapagoensis*, the prevailing color on the sides of the body is described as yellow. In *O. bauri* the coloration is about as in *Sigmodon hispidus*—the prevailing color being dusky gray, with only the slightest mixture of pale yellowish brown. The young are slightly darker than the adults; the female has a slight mixture of pale yellowish-tipped hairs.

O. bauri, and doubtless also *O. galapagoensis*, is a true *Oryzomys*, as regards the skull and dentition; it has, however, a much thicker, longer, and coarser pelage and larger ears than *O. palustris* and its near allies.

Of this species Dr. Baur writes me as follows : " On Barrington Island the small Rodent was pretty common ; it was found between the bushes near the shore, and also high up between grass and the lava rocks."

Of *O. galapagoensis* Darwin writes (Zoöl. Voy. Beagle, I, ii, p. 66) : "This mouse or rat is abundant in Chatham Island, one of the Galapagos Archipelago. I could not find it on any other island of the group. It frequents the bushes, which sparingly cover the rugged streams of basaltic lava, near the coast, where there is no fresh water, and where the land is extremely sterile."

The only other species of mammals thus far reported from the Galapagos Islands are two species of Eared Seals, namely, *Otaria jubata* (Forst.) and *Arctocephalus australis* (Zimm.), specimens of which were obtained in 1872 by the Hassler Expedition (see Allen, Mon. N. Am. Pinnipeds, 1880, pp. 208 and 211). The list of known indigenous species thus numbers only five.

Article V.—NOTICE OF SOME VENEZUELAN BIRDS, COLLECTED BY MRS. H. H. SMITH.

By J. A. ALLEN.

The present small collection, which has recently come into the possession of the Museum, was made by Mrs. H. H. Smith during a brief vacation trip to the northern coast of Venezuela.

The localities visited were Carúpano, on the coast, and El Pilar, a little way in the interior, the time spent at these points being less than ten days—Oct. 30 to Nov. 6, 1891. Although the collection numbers only about 60 specimens, 48 species are represented, several of which appear to be undescribed, and others not previously recorded from Venezuela. For this reason it seems desirable to give a complete list of the species, since the specimens are labeled with the locality and date of capture. It will be of further interest for comparison with Messrs. Sclater and Salvin's list of birds collected at the same points and at the same season of the year by Mr. A. Goering in 1866 (P. Z. S., 1868, pp. 165–173).

1. **Merula fumigata** (*Licht.*).—El Pilar, ♂ ad., Nov. 3.

2. **Polioptila leucogastra** (*Wied*). — Carúpano, ♂ ad., Nov. 5.

3. **Dendroica æstiva** (*Gmel.*).—Carúpano, ♀, Nov. 5.

4. **Setophaga ruticilla** (*Linn.*).—El Pilar, ♀ ad., Nov. 3.

5. **Euphonia trinitatis** *Strickl.*— ♂ ad.

6. **Tanagra glaucocolpa** (*Cab.*).—Carúpano, ♂, Nov. 5.

7. **Ramphocœlus atrosericeus capitalis,** subsp. nov.

Adult Male.—Similar to *R. atrosericeus* but smaller, the crimson of head, neck and breast much lighter, and extending much lower on the chest, with a distinct wash of crimson over the whole dorsal and ventral surfaces, nearly as in very dull-colored examples of *R. jacapa*; wings and tail velvety black, darker than in *R. atrosericeus*.

Adult Female.—Similar to the female of *R. atrosericeus*, but the lower parts and rump of a much stronger, clearer red, and the dusky portions of the plumage darker.

Measurements.—Male: Length, 6.55 in.; wing, 3.15; tail, 3.05; culmen, .60. *Female:* Length, 6.80 (skin evidently too long); wing, 3.15; tail, 3.08; culmen, .62.

Types, No. 56,195, ♂ ad., and 56,196, ♀ ad., El Pilar, Venezuela, Nov. 5, 1891; Mrs. H. H. Smith.

This subspecies is in some respects intermediate between *R. jacapa* and *R. atrosericeus*, agreeing with the former in size, and somewhat in the faint wash of crimson over the whole dorsal and ventral surfaces, but in general features is more decidedly allied to *R. atrosericeus*, with the differences of coloration distinguishing this species from *R. jacapa* more strongly emphasized. The red of the throat and head is much lighter (scarlet rather than crimson), giving greater contrast between the color of the head and back, thus suggesting the name *capitatis* selected for its designation. Its close affinity with *R. atrosericeus* is thus unquestionable, the color differences in other respects suggesting an exceedingly high-colored, small *R. atrosericeus*. The coast of Venezuela, however, is far to the northward of any point whence any form of *atrosericeus* has hitherto been reported, the habitat of this species being given as Bolivia and southern Peru. It also extends eastward into Matto Grosso, Brazil.

8. **Tachyphonus rufus** (*Bodd.*) = *T. melaleucus* auct. (See Bull. Am. Mus. Nat. Hist., III, No. 2, 1891, p. 359.) Carúpano, ♂ ad., Nov. 1, ♀ ad., Oct. 31; El Pilar, Nov. 3.—These specimens differ from our large Chapada (Matto Grosso) series in being much smaller with an absolutely larger bill; the male is more lustrous, with the white at the base of the inner webs of the wing-quills much more restricted. Doubtless a large series would show a well-defined average difference.

9. **Nemosia guira** (*Linn.*).—El Pilar, ♂ ad., Nov. 3.

10. **Buarremon**, sp. nov.?—Carúpano, juv., Nov. 5.

11. **Saltator olivaceus** *Cab.*—El Pilar, ♂, Nov. 5.

12. **Saltator albicollis** *Vieill.*—Carúpano, ♀, Nov. 1.

13. **Euetheia bicolor** (*Linn.*).—Carúpano, ♂, Nov. 5.

14. **Cardinalis phœniceus** *Bon.*—Carúpano, ♀, Nov. 5.

15. **Coryphospingus pileatus** (*Wied*). — Carúpano, two females, Nov. 1.

16. **Cassicus persicus** (*Linn.*).—El Pilar, ♂ ad., Nov. 6.

17. **Icterus xanthornus** (*Gmel.*).—Carúpano, ♂ and ♀ ad., Nov. 1.

18. **Lampropsar tanagrinus** (*Spix*).—El Pilar, "♂" and "♀," Nov. 5.

These specimens measure as follows: Length (skin), 7.50–7.75; wing, 3.50–3.55; tail, 3.40; culmen, .68. Two specimens labeled "Napo," in the Lawrence Collection (the only other specimens I have), measure as follows: Length (skin), 8.50; wing, 4.20–4.45; tail, 4.25–4.30; culmen, .80. The El Pilar birds are thus nearly one-third smaller than the Napo specimens (wings and tail nearly one inch shorter); they also differ in color, the El Pilar birds being nearly uniform deep black, with a slight greenish tinge, instead of the slight purplish cast seen in the Napo specimens. The tail also is much less graduated. There is thus about the same difference in size, and much more difference in color, between these two forms as there is between *Molothrus cabanisi* and *C. atronitens.* Whether these differences are simply individual, or perhaps sexual, or whether they characterize well-marked geographical forms, can not be determined without access to much additional material. Should the two forms prove separable, the Napo form will require a new name, as *Lampropsar guianensis* Cab. is without doubt a synonym of *L. tanagrinus.*

19. Lophotriccus subcristatus, sp. nov.

Allied to *L. spicifer* (Lafres.) of upper Amazonia, but much smaller (wing 1.65 instead of 2.00, tail 1.40 instead of 1.60), elongated blackish crest feathers shorter and edged with grayish green instead of grayish white, and the general coloration more greenish above, and more greenish yellow below. One specimen (sexed ♀) El Pilar, Nov. 3.

20. Hapalocercus fulviceps? (*Scl.*).

One adult specimen, sexed ♂, in molt, Carúpano, Nov. 5. Size of *H. fulviceps* or slightly smaller; wing-coverts and quills more broadly edged with fulvous, but apparently not otherwise different. If the same as *H. fulviceps* it extends the known range of the species far to the eastward and northward of previous records (western Ecuador and Peru).

21. **Mionectes oleagineus** (*Licht.*).—Two males, El Pilar, Nov. 5. Apparently not different from Bogota specimens.

22. **Ornithion pusillum** (*Cab. & Heine*).—Carúpano, Nov. 5. Two specimens, adult and young, both rather larger than the measurements usually given for this species. Wing, 2.12 and 2.25; tail, 1.90 and 1.92; culmen, .34 and .38; tarsus .66. The younger specimen is the larger, and differs much from the other in color, the general color above being more brownish olive, and the wing bars very much broader, and strong buff instead of clear whitish. The adult is in worn plumage, the young bird in fresh unworn plumage, which apparently satisfactorily explains the difference in coloration. The bill in the young bird, however, is much broader and deeper than in any example of *Ornithion* I have seen (compared with a series of 26 specimens).

23. **Sublegatus glaber** *Scl.*—Two specimens, Carúpano, Nov. 1 and 5. Provisionally referred to this species. Throat and whole breast pure deep gray, scarcely appreciably lighter on the throat; whole belly, crissum and under wing-coverts bright sulphur yellow; above with a strong wash of olive; wing-coverts and quills and outer tail-feathers edged with olivaceous gray, the former very broadly. These specimens are in fresh plumage, which may account for their strong tints, both above and below. The gray of the breast and throat and the yellow of the under parts is much purer and deeper than on the corresponding parts of *Elænea affinis* Burm.

24. **Myiozetetes texensis** (*Giraud*).—El Pilar, ♂, Nov. 5.

25. **Rhynchocyclus sulphurescens** (*Spix*).—El Pilar, ♂, Nov. 5.

26. **Pitangus sulphuratus** (*Linn.*).—El Pilar, ♀, Nov. 5.

27. **Myiodynastes audax** (*Gmel.*).—El Pilar, Nov. 5, one specimen.

28. **Contopus brachytarsus** (*Scl.*).—Carúpano, ♂, Oct. 30.

29. **Pipra aureola** *Linn.*—El Pilar, ♂, Nov. 6. "Legs and feet light purple."

30. **Tityra cayana** (*Linn.*).—El Pilar, ♀ ad., Nov. 3.

31. **Pachyrhamphus niger** *Spix.*—El Pilar, ♂, Nov. 3.

32. **Dendrornis susurrans** (*Jard.*).—El Pilar, Nov. 5, one specimen.

33. **Thamnophilus major** *Vieill.*—El Pilar, ♂, Nov. 3.

34. **Thamnophilus doliatus** (*Linn.*).—Carúpano, ♂ juv., Oct. 30.

35. **Formicivora intermedia** *Cab.*—Carúpano, Oct. 30 and Nov. 3, one ♂ ad. and two females.

36. **Doleromya fallax** (*Bourc.*).—Carúpano, ♂, Nov. 5.

37. **Chrysolampis moschitus** (*Linn.*).—Carúpano, ♂ juv., Nov. 6.

38. **Amazilia erythronota** (*Less.*).—Carúpano, two specimens, Nov. 5 and 6.

39. **Melanerpes subelegans** (*Bon.*)=*Picus tricolor* Wagler, 1829, not *Picus tricolor* Gmel., 1788).—Carúpano, ♂, Oct. 30.

40. **Dryobates kirki** (*Mahl.*).—El Pilar, ♀, Nov. 6.

41. Picumnus obsoletus, sp. nov.

Adult Male.—Above yellowish olive-brown, with faint subapical very narrow dark brown bars; wing-coverts olive brown, lighter yellowish apically and narrowly tipped with blackish; quills dark brown, the secondaries broadly edged externally with light greenish yellow; nasal plumes soiled white tipped with black; whole upper surface of head black, the crown spotted with orange red and the occiput with minute rounded spots of white, extending forward on sides to eyes; below yellowish, lighter or more whitish on the throat, each feather edged apically with a very narrow bar of black, nearly obsolete except on the breast; under wing-coverts strongly buffy white.

Length (skin), 3.35 in.; wing, 1.95; tail, 1.05; culmen, .46; tarsus, .50.

Type, No. 56,158, ♂ ad., El Pilar, Nov. 5, 1891; Mrs. H. H. Smith.

This species finds its nearest ally in *P. squamulatus* Lafr., from which it differs in smaller size, much more yellowish coloration, both above and below, and in the nearly obsolete squamation of both the upper and lower surface, resulting in a very strongly pronounced difference in general coloration. (Compared with Bogota specimens of *P. squamulatus.*) Its next nearest ally is doubtless *P. undulatus* Hargitt, from which, however, it seems obviously distinct.

42. **Galbula ruficauda** *Cuv.*—Carúpano, ♂, Oct. 30.

43. **Bucco macrorhynchus** (*Gmel.*).—El Pilar, ♂, Nov. 2.

44. **Trogon viridis** *Linn.*—El Pilar, ♂, Nov. 3.

45. **Ceryle americana** (*Gm.*).—El Pilar, ♀, Nov. 5.

46. **Psittacula guianensis** (*Swain.*).—Carúpano, ♀, Nov. 5.

47. **Scardafella squamosa** (*Temm.*).—Carúpano, ♀, Nov. 6.

48. **Columbigallina passerina** (*Linn.*). — Carúpano, ♂, Nov. 5.

Article VI.—DESCRIPTION OF A NEW GALLINULE, FROM GOUGH ISLAND.

By J. A. Allen.

Gough Island is situated in lat. 40° 19′ S., long. 9° 44′ W., about 200 miles southwest of the Cape of Good Hope, and about the same distance east of Tristan d'Acunha, respectively the nearest land to Gough Island. It is a mere volcanic islet, about seven miles long by three to four wide; and rises to a height of 4380 feet. Little seems to be known of its natural history.

The species here described is based on three skins, in fair condition, collected by Mr. George Comer, after whom the species is named. The specimens were sent to me, with other South Sea birds, for identification, by Mr. G. E. Verrill, of New Haven, Conn., through whose courtesy I am permitted to publish the following description :

Porphyriornis comeri, gen. et. sp. nov.

Similar in size and general structure to *Gallinula nesiotis* Scl., from Tristan d'Acunha, but differing from it in coloration, especially through the greatly reduced amount of white on the edge of the wings and on the flanks.

Head and neck dull black ; back brownish black, with, in some of the specimens, a faint tinge of olive ; wings similar, but less brown, with barely a trace of white on the inner surface of the carpus and on the edge of the wing at the base of the first primary, the outer vane of which is minutely edged with whitish ; lower surface of the body slaty black; three of the flank feathers on each side with a narrow shaft-streak of white near the tip ; lower tail-coverts white ; crissum black. Frontal shield and basal half of bill scarlet ; apical third of bill bright yellow. Legs and feet yellow, varied with reddish; lower third of tibia deep red. A well-developed light-colored spine at the bend of the wing.

Bill, from rictus, 1.10 to 1.25 ; depth of nostril, .50 ; width at nostril, .30 ; wing, 5.40 to 5.80 ; tail, 2.60 ; tarsus, 1.85 to 2.10 ; middle toe, 2.72 to 2.88.

Type, No. 56,701, Am. Mus. Nat. Hist., Gough Island, collected by Mr. George Comer. (Received in exchange from Mr. G. E. Verrill.)

In measurements this species agrees with *G. nesiotis*, except in the length of the tail, which is 2.60 in each of the three specimens instead of 3.30, as given by Sclater for *G. nesiotis*. The general coloration appears to be much darker, and the white on the carpus and edge of the wing is nearly obsolete, as are the white flank stripes, which, in *G. nesiotis*, Mr. Sclater says, are nearly as in *G. chloropus*. (See P. Z. S., 1861, p. 261, pl. xxx.) It agrees with *G. nesiotis* in its stout, thick bill and tarsi, short wings and inability to fly.

Mr. Comer, in his MS. notes, calls these birds "Mountain Cocks," and says: "They cannot fly and only use their wings to help them in running....They are quite plentiful and can be caught by hand. Could not get on a table three feet high. The bushes grow on the island up to about 2000 feet, and these birds are found as far up as the bushes grow....Tip of bill bright yellow, scarlet between the eyes. Legs and feet yellow, with reddish spots."

Mr. Verrill informs me that Mr. Comer obtained four skins of this species, which came in bad condition, having been merely preserved with salt. Mr. Comer was second mate of the sailing schooner 'Francis Adams.' When the party left Gough Island they took with them six live birds of this species, four of which died, in consequence of getting wet with salt water, soon after being taken on board the schooner; the other two reached this country alive, and after their arrival improved in health and flesh. They were kept tethered by a rope-yarn tied to the leg, and eventually both escaped.

A further account of the habits of this species will be published by Mr. Verrill, based on Mr. Comer's notes, in a general paper on Mr. Comer's collection of South Sea birds.

These two flightless, insular species of Gallinules seem well entitled to separate generic recognition. They combine the coloration of *Gallinula* with the short, thick bill and oval nostrils of *Ionornis*, and the stout feet of *Porphyrio*, with the added distinction of a greatly reduced wing, and the resulting inability to fly. I propose for this group the generic name **Porphyriornis**, with *P. comeri* as the type, to which may be referred *P. nesiotis* (*Gallinula nesiotis* Scl.).

Article VII.—LIST OF TYPES OF SOME SPECIES OF LEPIDOPTERA, DESCRIBED BY GROTE AND ROBINSON, IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

By William Beutenmüller.

In the present paper I desire to place on record a list of some of the types of the species of Lepidoptera described by Mr. A. R. Grote and the late Coleman T. Robinson. The specimens were donated to the Museum some years ago by Mr. Robinson, who, as far as I have been able to ascertain, also deposited a duplicate set of his *Tortricidæ*, as well as some of the types of the species which he described in conjunction with Mr. Grote, in the Museum of the Academy of Natural Sciences of Philadelphia. Dr. Henry Skinner and Prof. John B. Smith inform me that some of these types are still there, but that some of them have become lost.

All the species mentioned in this paper are labeled in Mr. Grote's handwriting, except where otherwise stated.

LYCÆNIDÆ.

Thecla lorata *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 171.—One female, from Virginia, labeled by Robinson.

Thecla inornata *G. & R.*, l. c. p. 323 (=*T. calanus*).—One specimen, from New York, labeled by Robinson.

Thecla henrici *G. & R.*, l. c. p. 174.—One example, from Pennsylvania, labeled by Robinson.

SPHINGIDÆ.

Hæmorrhagia gracilis *G. & R.*, Proc. Ent. Soc. Phil., Vol. V, p. 26, pl. iii, figs. 1, 2 (=*Hemaris gracilis*).—One male, from Canada, labeled by Robinson.

Hæmorrhagia floridensis *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 439, pl. xvi, fig. 20 (=*Hemaris floridensis*).—One male, from Florida.

Hæmorrhagia buffaloensis *G. & R.*, l. c. p. 437, pl. xvi, figs. 18, 19 (=*Hemaris buffaloensis*).—One male, from New York.

Hæmorrhagia thysbe var. **uniformis** *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 181 (=*Hemaris thysbe* var. *uniformis*).—One female, without locality.

Philampelus linnei *G. & R.*, Proc. Ent. Soc. Phil., Vol. V, p. 34, pl. iii, fig. 3.—Three examples, from Cuba, with label in Robinson's handwriting.

ZYGÆNIDÆ.

Alypia mariposa *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 329, pl. vi, fig. 40.—One female, from California.

Alypia dipsaci *G. & R.*, l. c. p. 327, pl. vi, fig. 37.—One female, from California.

Alypia sacramenti *G. &* R., l. c. p. 327, pl. vi, fig. 38.—One female, from California.

Euscirrhopterus gloveri *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 185 (=*Copidryas gloveri*).—One female, in rather poor condition, but still recognizable.

Melanchroia regnatrix *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 441, pl. xvi, fig. 5.—One male and one female, with Robinson's label.

Charidea bivulnera *G. & R.*, l. c. p. 365, pl. xiii, fig. 2.—I am not positive that the single male from Mexico, without a label, which I have before me is the type. It agrees in all particulars with the description and figure of the species, and being from the Robinson collection it is probably the type.

BOMBYCIDÆ.

Arctia achaia *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 334, pl. vi, figs. 45 and 46.—One male and one female, from California.

Arctia mexicana *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 369, pl. xiii, fig. 3.—Three males, from Mexico.

Parorgyia clintonii *G. & R.*, Proc. Ent. Soc. Phil., Vol. VI, p. 3, pl. i, fig. 2 and 3.—One male and one female, labeled by Robinson.

Parorgyia parallela *G. & R.*, l. c. p. 5, pl. i, fig. 5.—Male and female, labeled by Robinson.

Parorgyia cinnamomea *G. &* R., l. c. p. 6, pl. i, fig. 6.—Three males and one female, labeled by Robinson.

Parorgyia obliquata *G. & R.*, l. c. p. 4, pl. i, fig. 4.—Three females, from Rhode Island, labeled by Robinson.

Datana integerrima *G. & R.*, l. c. p. 13, pl. ii, fig. 4.—One male, from New York, labeled by Robinson.

Datana angusii *G. & R.*, l. c. p. 9, pl. ii, fig. 1.—Two males, from New York.

Heuretes picticornis *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 190.—One female and cocoon. It was described from the West Indies.

Sisyrosea inornata *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 372.—One female, from Pennsylvania. The specimen is without a label, but is one of the original specimens, and doubtless one of the types.

Adoneta pygmæa *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 189.—Three males, from Texas, with printed label.

Psephopæctes simulatilis *G. & R.*, l. c. Vol. I, p. 6, pl. i, fig. 1.—One male, from Mexico, somewhat faded, but still recognizable.

Heterocampa pulverea *G. &* R., l. c. p. 185, pl. iv, fig. 32.—One female, from Pennsylvania. The probable male of this species mentioned by Grote and Robinson (l. c. p. 186) is also in the collection.

Heterocampa elongata *G. & R.*, l. c. p. 184, pl. iv, fig. 30.—One female, from Pennsylvania, with label printed.

Heterocampa brunnea *G. & R.*, l. c. p. 180, pl. iv, fig. 28.—One female, from Pennsylvania, with label printed.

Citheronia mexicana *G. & R.*, Ann. Lyc. Nat. Hist., Vol. VIII, p. 382, pl. xiii, fig. 1.—One female, from Mexico, labeled by Robinson.

PYRALIDÆ.

Asopia anthœcioides *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 15, pl. ii, fig. 9.—Three males, from New York.

Siparocera nobilis *Rob.*, Grote, Ann. Lyc Nat. Hist., N. Y., Vol. II, p. 128.—Four males, from Pennsylvania, labeled "*Callocera nobilis*" by Robinson.

Botys unimacula *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 14, pl. ii, fig. 8.—One male, labeled by Robinson.

Botys laticlavia *G. & R.*, l. c. p. 17, pl. ii, fig. 12, ♂.—One male, from Pennsylvania.

Botys deffissa *G. & R.*, l. c. p. 19, pl. ii, fig. 16 (=*B. tyralis* Guen.).—One male, from New Orleans.

Botys haruspica *G. & R.*, l. c. p. 19, pl. ii, fig. 14, ♂ (=*B. acrionalis* Walk.).—Three males.

Botys generosa *G. & R.*, l. c. p. 20, pl. ii, fig. 10, ♂ (=*B. orphisalis* Walk.).—One male, from Pennsylvania.

Botys ventralis *G. & R.*, l. c. p. 21, pl. ii, fig. 23, ♂ (=*B. argyralis* Hb.).—One male and one female, from Pennsylvania.

Botys posticata *G. & R.*, l. c. p. 22, pl. ii, fig. 25, ♂ (=*B. similalis* Guen.).—One male, from Pennsylvania, labeled by Robinson.

Botys citrina *G. & R.*, l. c. p. 23, pl. ii, fig. 20, ♀ (=*B. helvialis* Walk.).—One female, from Pennsylvania.

Botys marculenta *G. & R.*, l. c. p. 23, pl. ii, fig. 21, ♀ (=*B. obliteralis* Walk.).—One female, from Pennsylvania.

Botys insularis *G. & R.*, l. c. p. 24, pl. ii, fig. 24, ♂.—One male, from Cuba.

Botys coloradensis *G. & R.*, l. c. p. 25, pl. ii, fig. 18.—One female, from Colorado.

Botys gracilis *G. & R.*, l. c. p. 25, pl. ii, fig. 15 (=*Blepharomastix ranalis* Guen.).—One female, from Pennsylvania.

Botys adipaloides *G. & R.*, l. c. p. 26, pl. ii, fig. 19.—Fine examples, from Pennsylvania, Texas and Virginia, labeled by Robinson.

Botys fabrefacta *G. & R.*—Two males, from Pennsylvania. No description of this species was published; it is probably some well-known species.

Botys plectilis *G. & R.*, l. c. p. 27, pl. ii, fig. 17 (=*B. tertialis* Guen.).—One female, from Pennsylvania, labeled by Robinson.

Pantographa limata *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 464, pl. xvi, figs. 16 and 17.—Two males, from West Virginia, labeled by Robinson.

TORTRICIDÆ.

All the following specimens are provided with labels in Robinson's handwriting:

Teras trisignana *Robs.*, Trans. Am. Ent. Soc., Vol. II, p. 282, pl. vii, fig. 69.—One female, from West Virginia.

Teras deflectana *Robs.*, l. c. p. 283, pl. vii, fig. 71.—Two females, from Pennsylvania.

Teras inana *Robs.*, l. c. p. 281, pl. vii, fig. 65.—One example, without locality.

Teras nigrolinea *Robs.*, l. c. p. 281, pl. vii, fig. 67.—Two males.

Tortrix gurgitana *Robs.*, l. c. p. 263, pl. iv, fig. 16 (=*Cacœcia purpurana* Clem.).—Two females, from Illinois.

Tortrix fumosa *Robs.*, l. c. p. 268, pl. iv, fig. 19 (=*Cacœcia fractivittana* Clem.).—One female, without locality. It was described from Ohio.

Tortrix zapulata *Robs.*, l. c. p. 264, pl. i, fig. 7.—Two males, from Illinois.

Tortrix furvana *Robs.*, l. c. p. 265, pl. i, fig. 9 (=*Cacœcia argyrospila* Walk.).—One example.

Tortrix parallela *Robs.*, l. c. p. 267, pl. iv, fig. 17 (=*Cacœcia parallela*). Two males, from Pennsylvania.

Tortrix palludana *Robs.*, l. c. p. 275, pl. vi, fig. 45 (=*Cacœcia fervidana* Clem.).—Two males and two females, from Pennsylvania.

Tortrix lamprosana *Robs.*, l. c. p. 264, pl. i, fig. 5 (=*Pandemis lamprosana*).—Two females, from Pennsylvania.

Tortrix limitata *Robs.*, l. c. p. 264, pl. i, fig. 5 (=*Pandemis limitata*).—One male and one female, from Pennsylvania.

Tortrix pallorana *Robs.*, l. c. p. 266, pl. i, fig. 13.—Three males and two females, from Illinois.

Tortrix nigrida *Robs.*, l. c. p. 268, pl. iv, fig. 20 (=*T. fumiferana*).—Two males.

Tortrix violaceana *Robs.*, l. c. p. 271, pl. v, fig. 31 (=*Œnectra violaceana*).—One specimen.

Tortrix caryæ *Robs.*, l. c. p. 270, pl. iv, fig. 26 (=*Dichelia caryæ*).—One male, from Illinois.

Tortrix pettitana *Robs.*, l. c. p. 269, pl. iv, fig. 22 and 23 (=*Cenopis pettitana*).—One male and two females.

Tortrix irrorea *Robs.*, l. c. p. 274, pl. v, fig. 44 (=*Œnectra irrorea*).—One specimen, probably a male.

Conchylis 5-maculata *Robs.*, l. c. p. 284, pl. viii, fig. 76.—One example.

Conchylis angulatana *Robs.*, l. c. p. 286, pl. viii, fig. 81.—Two examples, from West Virginia.

Conchylis argentilimitana *Robs.*, l. c. p. 287, pl. viii, fig. 82.—One example, from Pennsylvania, in poor condition, and barely recognizable.

Conchylis labeculana *Robs.*, l. c. p. 287, pl. viii, fig. 83.—One specimen, from Pennsylvania.

Article VIII.—ON THE EARLIER STAGES OF SOME SPECIES OF NORTH AMERICAN MOTHS.

By William Beutenmüller.

While collecting entomological specimens in the vicinity of New York City, for the Museum, during the summers of 1889–'90, I have been enabled to make the following observations on the earlier stages of some moths. I am aware that I have been anticipated by other entomologists in some of the notes which follow, yet the most part, as far as I am aware, have not been heretofore recorded :

Phlegethontius celeus *Hub.*

Some larvæ of this species are brownish black, instead of green, which is their usual color, and have the irrorations yellow, as are also the oblique and lateral stripes, the caudal horn being black. The face in this variety has the centre always paler than the sides. Spiracles velvet black with a lilac ring.

Anisota stigma *A. & S.*

After Second Moult.—Body color brownish black. Head bright orange red. At the base of all the spines and over the body irregularly are numerous white irrorations. There are no other markings. The spines on the segmental processes are also white. Length, 25 mm.

After Third Moult.—There is little change, except that the color is now brownish black and the spines have the same white irrorations. Length, 35 mm.

Full-grown Larva.—Body color reddish brown. Head testaceous or chestnut. Each segment with six rather long black spines, and the whole of the segments covered with white warty irrorations, almost tubercular, those on the dorsum being the largest. Spiracles jet black with whitish ring and a whitish streak in the centre. Anal extremities with testaceous tinge. Feet and legs reddish testaceous. Length, 60 mm.

Food-plants.—Oak, Chestnut, Hazel.

Pupa.—Very rough and deeply punctured. The segments are surrounded by large series of spines, those in front of the segments the largest. On the posterior edge a row of small spines. Cremaster long, bifurcate at tip. Length, about 30 mm.

Anisota senatoria *A. & S.*

Egg.—The eggs, deposited on the underside of a leaf, are ovate, flattened and attached by the widest space. They are dull white, changing to slate and afterwards to almost black. After exclusion of larva, the eggs are brightly opalescent. Width, 1 mm.; height, .5 mm.

Young Larva.—Head jet black, shining. Body dull cream color; the segments having a corrugated appearance. On the third segment are two very long spinous processes, directed a little forward, jet black; on the eleventh, twelfth and thirteenth segments are a few very small black dots, not visible without a lens. In the middle of these segments there is also a dark shade. The feet are jet black; abdominal legs concolorous with the body. In the centre of the second segment is a very narrow black line. In feeding, as the body is filled with food, it becomes dusky. Length, 6 mm.

After First Moult.—Jet black, with two narrow, waved, yellowish lines on the lateral region and a broader waved line above the base of the legs. Head and anal segment jet black.

After Second Moult.—The body is now slightly olive, with the lines more distinct and brighter in color. The space immediately below the spiracles is orange brown. Length, 22 mm.

After Third Moult.—Body now jet black, with the lines very distinct and the spinose tubercles longer and rougher; those of the anal segment being now more numerous and spinose. Length, 31 mm.

After Fourth Moult.—Body color jet black. Head with deep fovea, triangular over the mouth parts. Cervical shield black. Two dorsal and one subdorsal stripes of dull orange, slightly waved and broken. One broader lateral stripe and one stripe enclosing the spiracles of the same color, and a ventral stripe a little paler. Spines and legs all jet black, as is also the anal segment. Length, 38 mm.; length, when fully grown, 55 mm.

Food-plants.—Oak, Chestnut.

Ichthyura vau *Fitch.*

Before Last Moult.—Head pale chestnut. Body clothed with short hairs; dorsal region greenish white, transversed by three lines of pale reddish brown; lateral region reddish brown, marbled with white. Spiracles black. On the third and on all the segments thence to the ninth are two pale yellow tubercular spots, placed at the anterior junction of the segments. These are lost on all the posterior segments, or, at least, but indistinctly seen.

Full-grown Larva.—Entirely greenish white, with all the markings very much fainter than in the previous stage, except the yellow tubercular spots, which are now much more distinct and continued in a series of eight around the anterior segments. Length, 27 mm. September 24, on Willow (*Salix babylonica*).

Gluphisia trilineata *Pack.*

Full-grown Larva.—Pale apple green, with a broad subdorsal stripe of lemon yellow. Spiracles indicated by a yellow shade, and above these a very faint yellow line. The head has two very minute black dots on each side of the mouth parts. Some individuals differ from the one just described by having on the third, fourth, eighth, ninth, tenth and following segments a transverse pinkish band in the middle and surrounded by whitish. In all other respects similar to the former.

Food-plant.—Willow (*Salix*), September 24.

Adoneta spinuloides *H. S.*

The larva varies considerably in the dorsal region, passing from bright scarlet through pale pink, and in some cases assuming on the dorsum the pale-green ground color.

Acontia delecta *Walk.*

Full-grown Larva.—Ground color, dark chocolate brown, almost black. Head pinkish white with black blotches, and on the posterior portion are two orange blotches. Segments two, three and four have four orange patches on the edges of which are black piliferous tubercles. On the other segments the orange patches are much larger and of various shapes, those of the hinder segments being on the dorsum a double oval. From the fifth segment along the lateral region is a row of clear white patches, broken into twos and threes, and enclosing also velvet black tubercular spots. The body is slightly swollen anteriorly, narrowing gradually to the anal segment. Feet and legs black, spotted at their base with orange and white. Length, 35 mm.

Food-plant.—Marsh-mallow (*Hibiscus moscheutos*).

Panopoda carneicosta *Guen.*

After Fourth Moult.—Body color yellowish green, the segments covered with very fine blackish-brown waved lines, giving a rather dirty appearance to the larva. These lines are composed of irrorations, and leave the dorsum with a single line and a double subdorsal. Head paler than the body, with a yellow line at the back on the posterior portion. Mouth parts, feet and legs orange, as are also the anal casps, which are long and very widely spread.

Full-grown Larva.—The body color is now a little darker. The band across the head is now united to the subdorsal line and forms a continuous line. There also eight oblique yellowish-white lines on the lateral region. Length, 40 mm.

Food-plants.—Oak, Hickory, Willow.

Panopoda rufimargo *Guen.*

Full-grown Larva.—Paler green than *Panopoda carneicosta.* Head with waved brownish irrorations, but no lines as in *P. carneicosta.* There is a white subdorsal line, and the feet and legs are whitish, as is also the underside of the body. Length, 45 mm.

Food-plant.—Oak.

Adipsophanes miscellus *Gr.*

The caterpillar transforms above the surface of the ground and spins an oval cocoon, mixed with grains of sand. The pupa is long and narrow in form and pale pitchy, almost chestnut brown and very shining. The abdominal segments are rugosely punctate on the anterior half. Spiracles dark pitchy. Cremasters composed of two spines, short but sharp. Length, 23 mm.; width, 6 mm. at the middle segments ; anal segments, 4 mm.

Perigea xanthioides *Guen.*

After Second Moult.—Dull flesh color, with a blackish tint and a very faint white dorsal line, which is joined to a triangular stripe on the head. There are also faint traces of subdorsal waved lines. Length, 10 mm.

After Third Moult.—The fourth and fifth segments are now swollen into a hump. Head small, black, with narrow white stripes in front, meeting on the crown of the head and then joining a dorsal white stripe, which is lost at the fourth segment, reappearing on the tenth and continued to the anal segment. The fourth and fifth segments are blackish in front, triangularly flesh colored behind, and there is a flesh-colored shade along the sides. The spiracles on the fourth and fifth segments are dull yellow and there are faint waved flesh-colored lines along the lateral region. Length, 22 mm.

After Fourth Moult.—Body now much lighter in color, having a flesh-colored tint, particularly at the posterior edge of the segments. The white dorsal shade line now continuous. The dark shade on the anterior segments is produced triangularly behind. The tenth segment also raised into a hump. Length, 30 mm.

After Fifth Moult.—Now still paler, the pale stripes being pinkish, and the body covered with brown or blackish irrorations. Dorsal stripe clear white. Length, 42 mm.

Food-plants.—Iron-weed (*Vernonia noveboracensis*), Trumpet-weed (*Eupatorium purpureum*).

Article IX.—SOME NOTES ON TRANSFORMATIONS OF AUSTRALIAN LEPIDOPTERA, MADE BY THE LATE HENRY EDWARDS, WITH NOTES AND ADDITIONS.

By WILLIAM BEUTENMÜLLER.

It is with melancholy pleasure that I present the following notes on some transformations of Lepidoptera, made by my deceased friend, Mr. Henry Edwards, during his last visit to Australia in 1889–'90. To these notes I have added the descriptions of the cocoons of *Discophlebia catocalina* Feld. and *Pelora oxleyi* McL., as was originally intended by Mr. Edwards, to complete the present paper, otherwise all the notes are his, except those in brackets. In the 'Victorian Naturalist,' Volume VII, 1890, p. 20, Mr. Edwards announced his intention of publishing a "Bibliographical List of Transformations of Australian Lepidoptera." This work was begun by Mr. Edwards shortly before his death, but unfortunately was not completed. I am now continuing Mr. Edwards's MSS. notes of this work, and hope to have the same ready for publication before long.

Discophlebia catocalina *Feld.*

Cocoon.—Oblong oval, formed of fine fragments of earth and with a few grains of the excrements of the larva, neatly and firmly agglutinated. The interior is lined with a thin case of silk, and the imago escapes not at either of the extreme ends, but from the upper side, near the larger end of the cocoon. Length, 30 mm.; width, 17 mm.

Pupa.—Chestnut brown, smooth, rather short and swollen anteriorly.

One cocoon, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Darala acuta *Walk.*

Cocoon.—Composed of two layers, the inner one consisting of finely spun silk, rather loosely and irregularly woven; the outer one of coarse silk, amongst which the larval hairs are thickly intermingled. These hairs are short, spiny, bright chestnut in color, and extremely poisonous when penetrating into the skin. They are difficult to extract and cause the flesh to smart and ache for several days. The silk of the outer cocoon is pale chestnut. Length, 60 mm.; width, 25 mm.

The cocoon is mostly found beneath the bark of *Eucalyptus*, and on the side of attachment only the inner cocoon is seen; through this the pupa is clearly visible. This is pale pitchy in color, rather short, rounded in front and wrinkled over its whole surface.

[One example, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Pelora oxleyi *McL.*

Cocoon.—Oval, flattened on the side of attachment and almost as broad as long, dark brown in color, with a grayish coating of glutinous matter; surface rather smooth. In appearance the cocoon resembles that of a *Limacodes*, in fact it is almost inseparable. The imago, when ready to make its escape, cuts out a circular piece at the end of the cocoon, as is also the case with other species of *Limacodidæ*. Length, 15 mm.; width, 11 mm.

Five specimens, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Mr. Edwards once told me that the larva feeds on *Eucalyptus robusta*, and gives out a very viscid humor when disturbed.

Rhinogyne calligama *Feld.*

Cocoon.—Closely, but finely spun, with many extraneous materials mixed with the outer coat. If the larva is placed in a box to transform, part of the paper lining will be used, and if leaves or dry twigs be present, they also will be sparingly utilized. The color is dull pale brown. Length, 35 mm.; width, 18 mm.

Pupa.—Rounded in front, cylindrical, covered with tawny bristly hairs, very finely punctured and slightly shining over the whole surface. The color is pale pitchy. Length, 28 mm.

[One cocoon, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Oiketicus omnivorus *Fereday.*

Larva.—Head and three following segments sordid white, the head being thickly spotted with brown dots, irregularly placed. Second, third and fourth segments with a double rather broad line, of which the edges are irregular, narrowing at the base of the fourth segment, until the second lines are almost united. There are also two lateral lines, and between these another series of irregularly placed brown spots. The rest of the body is concealed within the case and is pitchy brown. The feet are sordid white at their base and pitchy at their tips. Mouth-parts pitchy. Length, 20 mm.

Clania tenuis *Rosenst.*

Larval Case.—Somewhat resembling in appearance that of *Entometa ignobilis* Walk., but much smaller, and composed of very much smaller twigs, all nearly equal in length and regularly united. The imago is difficult to raise, as indeed are all the *Psychidæ.* The cases are common on fences in the neighborhood of Melbourne, but the imago is very rarely seen. Length, 18 to 24 mm.

[Nine specimens, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Endoxyla cinerea.

Pupa.—General color pale chestnut brown, darkest posteriorly and over the head and thorax. The segments are slightly corrugated and have each a double row of raised roughened points, projected in the form of a ridge. Beneath the posterior of the abdominal legs is marked by a roughened ovate space. The anal segment is smooth, with a double furrow. The cremaster is rough, short, swollen, with a series of small points beneath. Head and thorax very glossy, wrinkled, the former rugosely punctate in front. Wing cases thin, the margins thickened, with the course of the veins indistinctly marked.

[Length of male, 75 mm.; width, 18 mm. Of female, 90 mm.; width, 24 mm.

Nine specimens, Adelaide, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

The species stands by this name in the Edwards Collection, though I do not know the authority. According to Mr. Edwards's notes, it is the species so common and destructive to *Eucalyptus* trees in the neighborhood of Adelaide. He has found as many as sixteen empty pupa cases sticking out of one tree. It is paler in color than *E. eucalypti*, and much larger.—W. B.]

Thyridopteryx herrichii *Westw.*

Pupa.—Pitchy black, fusiform, slightly swollen about the head parts, which are very finely punctate. Abdominal segments shining anteriorly, but roughened and dull on the posterior half. Cremaster very short, bifurcate, bent under; spiracles large, wart-like, very rough. Length, 12 mm.

[One specimen, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Antheræa helena *Scott.*

Cocoon.—Very closely and thickly spun, rather large and more elongate in form than that of *A. eucalypti*. Color bronze brown, very glossy and with a large quantity of glutinous matter mixed with the outer coat. Leaves and twigs are generally associated with the cocoon. It is difficult to define the difference in words, but an experienced eye will soon detect the difference between this and the cocoon of *A. eucalypti.* Length, 45 mm.; width, 28 mm.

[One specimen, Sidney, N. S. W., Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Antheræa janetta *White.*

Egg.—Oval, very slightly flattened on the upper side, rather glossy, cream white, without markings. They are 2 mm. in length and a little more than half as broad. About 150 eggs are deposited by the parent.

Antheræa eucalypti *Scott.*

Egg.—Larger than the preceding species, though exactly like it in form, color dirty white, rather than cream color, the surface under a high power, showing traces of very fine-waved sculptures. The eggs are always laid on the edges of a leaf.

Article X.—NOTES ON THE TRANSFORMATIONS OF SOME SPECIES OF LEPIDOPTERA.

By Henry Edwards and S. Lowell Elliot.

Edited, with additions, by William Beutenmüller.

The following notes were made by the late Messrs. Henry Edwards and S. Lowell Elliot on the earlier stages of some species of Butterflies and Moths in the collection of the latter.

The Elliot Collection of Insects was generously donated to the Museum by his widow, while the notes passed into the hands of Mr. Edwards, who kindly gave me permission, shortly before his death, to publish them, as a continuation of the paper published by him, in conjunction with Mr. Elliot, in 'Papilio,' Vol. III, pp. 125–136. To the notes that follow I have added the description of the larva and pupa of *Doryodes acutaria*, and the notes in brackets.

Papilio cresphontes *Cram.*

Egg.—Ovate, attached by a rather flattened base to the upperside of the leaf. It is covered with an orange mealy substance, which, after exclusion of the caterpillar, renders the egg slightly obscure.

Young Larva.—Olive green, with the third, fourth, fifth, eighth and ninth segments somewhat darker, with a number of tubercles on each. Length, 3 mm.

After First Moult.—Head in front, with a triangular white mark. Body darker than in the previous stage, with paler portions more in contrast. The piliferous tubercles are six to each segment, those of the second segment being the largest. Length, 8 mm.

After Second Moult.—The body color is now blackish olive, and the paler portions on the fourth and terminal segments dull pink, with an olive stain, the pink shade reaching to and enclosing the spiracles. The tubercles are larger and very shining. Length, 15 mm.

Lycæna comyntas *Godt.*

Young Larva.—Dull green, the dorsal region elevated, covered with short soft hairs; a faint dorsal line of dull olive green, composed of two oblique stripes meeting in the centre, and a lateral stripe of the same shade similarly composed. Mouth-parts and head pale testaceous; legs, concolorous.

After Third Moult.—The body in this stage is purplish brown, with a well-defined dorsal line of darker shade, and two oblique narrow paler stripes on each segment. Lateral line below the spiracles, white; underside, including legs, dull greenish.

Full-grown.—The colors are brighter, and the oblique whitish stripes form a triangular blotch on each segment, joining the dorsal line and becoming a portion of it. They are reddish lilac, and are edged narrowly with white. The three terminal segments have these marks very faintly indicated. The lateral line is also dull lilac.

[*Food-plant.*—*Lespedeza*, feeding amongst the bunches of the flowers, and always surrounded by large quantities of ants.]

Datana major *G. & R.*

After Second Moult.—Ground color bright reddish brown. Head and first segment wholly reddish brown, as is also the anal segment. There is a series of eight very bright lemon-yellow stripes—the space on the dorsal region between the stripes being the widest, as is usual in the genus. Underside wholly reddish brown.

After Third Moult.—Head greatly increased in size. First segment reddish brown only on the dorsal region. Stripes still more distinct and very vivid yellow. Underside reddish brown with a yellow ventral stripe.

Full-grown Larva.—Ground color of body jet black. Head and middle of first segment bright chestnut red. Each segment bears a series of eight broken stripes of bright canary yellow, the patches being composed of oblong pieces, except those above the base of the legs, where they are quite irregular in shape.

The feet and legs are bright chestnut red. Segments sparsely covered with sordid white hairs; anal claspers bright chestnut red. The stripes and patches in some broods are white instead of yellow. Length, 60 mm.

Food-plant.—Andromeda ligustrina.

[I found the larva feeding on Witch-Hazel (*Hamamelis virginica*) at West Woodstock, Conn., last September. This is a new food-plant for the species.]

Acronycta dactylina *Gr.*

Full-grown Larva.—Body dull black. The hairs of the dorsal region are tawny brown, those of the lateral region clear white, the caterpillar having the appearance (when moving, and the segments being devided) of the skin of a tiger, the colors being precisely the same. The head is jet black, shining. The fifth, seventh and twelfth segments bear a single median pencil of black hairs. Spiracles, cream white; underside and legs wholly black. Length, 50 mm.

[*Food-plants.*—Willow (*Salix*); White Birch (*Betula alba*).]

Hadena turbulenta *Hüb.*

The larva of this species, before undergoing the change to pupa, collects small masses of sand and of the particles forms a cocoon, which is ovate and regular in outline. The pupa is thickened about the head parts and wing-cases, and very much roughened, while the abdominal region is smooth and shining. Length, 21 mm.

[The larva feeds on Catbriar (*Smilax rotundifolia*) in large swarms. It was described by me in the 'Canadian Entomologist,' Vol. XX, p 136.]

Mamestra legitima *Gr.*

After Second Moult.—Very pale apple green, with a broad dorsal and two narrow lateral white stripes, the spaces between filled with white specks. The head and second segment are free from white and are wholly pale greenish. Head rather small with the mouth-parts slightly pitchy. Length, 15 mm.

[*Full-grown Larva.*—In this stage the larva has become slightly yellowish green, with the dorsal line strongly marked, the lateral less so and of a bright yellowish tint. The speckles have become very decidedly yellow, with the spots fewer and yellower. The lateral line is broader towards the anal segment. Length, 30 mm.

Food-plant.—Wild Cherry (*Prunus serotina*).]

[Doryodes acutaria *H. S.*

Full-grown Larva.—Body pale ashen brown, with a number of very narrow, indistinct longitudinal stripes of almost the same color as the body, a broad indistinct stripe on the dorsum, and along the subdorsal region and sides a pale ochreous stripe, followed by one a little deeper in color. Underside paler than above, and also with a number of indistinct stripes. Head of the same color as the body with a number of stripes. On the eighth and ninth segments a pair of abdominal legs, of the same color as the body, as are the anal and thoracic legs. Length, 34 mm.

The larva is a semi-looper, and when at rest mimics a blade of withered grass. It lives on species of grass found in salt marshes, and spins an elongated cocoon between pieces of grass and stems. Length, 30 mm.; width, 5 mm.

The pupa is reddish brown, smooth, and covered with a bluish white farinaceous matter. Sides nearly parallel, and the posterier extremity of the last segment bluntly rounded. Length, 15 mm.; width, 3 mm.]

Chamyris cerintha *Tr.*

Full-grown Larva.—Head light olive gray, with two oblique purplish-brown stripes. Dorsal region purplish brown, with two subdorsal stripes of pale pinkish white. Underside and extreme sides dull green. Anal segment and claspers very long. Each segment on the dorsum has four small concolor tubercles, and there are a number of long hairs over the whole surface. Feet and abdominal legs pinkish brown. The tubercles on the last segment are larger than the others. Length, 1.10 mm.

Changed to pupa August 23, on ground, between leaves drawn together with a few silken threads. The pupa is pale ochreous, and rather long.

Food-plant.—Cratægus.

Ennomos alniaria *Linn.*

The larva spins a thin but firm ovate elongated whitish web on the underside of a leaf. The web is open at both ends so as to allow the insect easy escape. The pupa is pinkish white without any markings, and is suspended inside the web. It is roughened on all the segments, but the spaces between are semi-transparent and yellowish. The pupa is also covered with a mealy substance. Length, 35 mm. Length of web, 35 mm.

Chœrodes clemitaria *A. & S.*

Full-grown Larva.—Head large, produced in front. Third segment very much swollen on the crown, but forming only one tubercle and looking like a portion of the head, until examined with a lens. The tubercle is not divided as in *Eubyja cognataria* Guen. Body purplish brown, marbled with a paler shade, each segment with eight slightly raised pale points, two in centre of segment, two nearer the posterior edge, and two near the spiracles on each side. On the seventh segment are two large tubercles raised much above the surface, shaded with chestnut brown, and two swollen ones on the twelfth segment of the same color. The spiracles are dull orange, edged with black, that of the second segment appearing in front as if upon a portion of the head. Underside of body marked like the upper, the lateral fold, below the spiracles, being in twisted corrugations. Length, 55 mm.

[*Food-plant.*—Dogwood (*Cornus florida*).]

Eccopsis inornatana *Clem.*

Full-grown Larva.—Pale vivid apple green, with yellowish hairs. Head dull jet black, also the second segment, with a very few hairs. Feet, legs and underside wholly apple green. Length, 20 mm.

[*Food-plant.*—Wild Cherry (*Prunus serotina*).]

Cacœcia rosana *Linn.*

Full-grown Larva.—Dull whitish green. Head and posterior half of the second segment dull black. There are also two blackish spots on the sides of the second segment. The feet are pitchy black, and the abdominal legs the same color as the body. Length, 13 mm.

Cacœcia parallela *Robs.*

Full-grow Larva.—Dull olive green. Head dull orange; second segment paler yellow, with two black dots in front on a narrow white line, and a black semi-circular band passing along the base of the segment and ending at the exterior margin. The remaining segments have each eight white tubercular spots from which spring whitish hairs. Feet blackish. Abdominal legs concolorous with the body. Length, 20 mm.

Food-plants.—Willow, Aster.

Article XI.—FOSSIL MAMMALS OF THE WAHSATCH AND WIND RIVER BEDS. COLLECTION OF 1891.

By HENRY FAIRFIELD OSBORN and J. L. WORTMAN.

With One Plate and Eighteen Figures in Text.

INTRODUCTION.

This paper is mainly given to a description of a collection made by Dr. Wortman in the Wahsatch (Big Horn) and lower Bridger (Wind River) beds during the summer of 1891. It includes the following special articles, each writer being responsible only for his own:

Many new facts of great interest are brought out by the material in this collection, although Professor Cope has worked for years upon the Wahsatch fauna, with the assistance of Dr. Wortman in the field.

1. The lower jaw of *Anaptomorphus homunculus* is found to contain three premolars, instead of two, as in the type species *A. æmulus* (p. 102).

2. The genus *Palæonictis*, hitherto found only in the Suessonian of France is also found in the American Wahsatch. The complete dentition and the facial region of the skull show that it is an extremely modified type, with only a single fully functional upper molar. It represents a family, the Palæonictidæ, including *Ambloctonus* (p. 106), and perhaps *Patriofelis* (p. 97), and is more like the Cats than any Creodont which has yet been found (pp. 95, 103).

3. Additional remains of *Oxyæna* show that the manus of this Creodont had a separate scapho-lunar and an os-centrale; the lumbar vertebræ have involuted zygapophyses; the pes is not cleft as Cope has described it. The incisors were $\frac{3}{3}$ (p. 109).

4. Among the Mesonychidæ is a small new form related to *Dissacus* of the Puerco, and a very large new species of *Pachyæna*, by far the largest Creodont which has yet been found in the Wahsatch (p. 112).

5. The genus *Anacodon*, which has been doubtfully placed by Cope among the Condylarthra, is found to belong to the group of Creodonts with tubercular molars near *Arctocyon*. The upper and lower molar cusps are obtuse and covered with a great number of accessory tubercles; the premolars are reduced in number and pointed (p. 115).

6. Complete limbs of *Coryphodon* show that the fore foot was digitigrade, as in the Elephant, while the hind foot was fully plantigrade, the whole plantar surface resting upon the ground as in the most primitive Ungulates (pp. 120–122).

7. The complete dentition of *Systemodon*, the earliest form of Tapir, is described (p. 124).

8. The complete limbs of *Heptodon* (Wind River), show that this animal belongs, with *Helaletes* of the Bridger, to a side line of small Perissodactyls with greatly reduced lateral toes. This family of Helaletidæ extended from the lower Eocene into the Miocene; it is not ancestral to the Tapirs as Marsh supposed, nor is it (*Heptodon*) ancestral to the *Hyrachyus* series as Cope has suggested. The tooth structure is intermediate between the two. The foot structure is highly modified and aberrant both in the marked shortening of the lateral digits and in the long narrow terminal phalanges. *Heptodon calciculus* was a small, light limbed animal, somewhat of the dimensions of the Peccary (p. 129).

9. Many additional characters of *Palæosyops borealis*, the earliest known representative of this important Bridger genus, are noted (p. 132).

We pass by a large number of forms in the collection in which there is nothing to be added to the observations of Cope.

DISTRIBUTION TABLE.

Number of individual Specimens of each Genus.	Preliminary Reference of Genera and Species.	Wahsatch.			Bridger. (Wind River.)
		Gray Bull.	Clark's Fork Basin.	Buffalo Basin.	Wind River Basin.
	Primates.				
40	Hyopsodus	×	....	×	
16	Pelycodus	×	....	×	
2	Cynodontomys	×			
4	Anaptomorphus homunculus	×	...	×	
	Rodentia.				
5	Plesiarctomys	×	....	×	
	Creodonta.				
1	Palæonictis occidentalis	×			
8	Oxyæna lupina	×	....	×	
	" forcipata	×			
8	Stypolophus (3 species)	×	....	×	
5	Miacis canavus	×	....	×	
	" brevirostris	....	....	....	×
	" edax	×	....	×	
6	Didymictis leptomylus	....	....	×	
	" dawkinsianus	×			
	" curtidens	×			
3	Anacodon ursidens	....	....	×	
8	Pachyæna ossifraga	×	....	×	
	" gigantea	×			
	Tillodontia.				
6	Esthonyx	×	....	×	
	Tæniodonta.				
1	Calamodon simplex				
	Amblypoda.				
31	Coryphodon radians	×	....	×	? ×
	" elephantopus	×	....	×	
	" obliquus	×			
	" anax	×			
	Condylarthra.				
16	Phenacodus primævus	×	×		
1	" wortmani				×
	Perissodactyla.				
69	Hyracotherium	×	×	×	×
50	Systemodon tapirinus	×	....	×	
	" semihians	×			
2	Heptodon calciculus	....	....	...	×
1	Palæosyops borealis	....	....	....	×
	Artiodactyla.				
3	Pantolestes	×			

In the field great care was taken to observe and record the localities, and especially to note whether the fossils were from the lower, middle, or upper portions of the great Wahsatch beds of the Big Horn Basin, which are variously estimated at 2000 to 3000 feet in thickness. Of course this depth of rock represents a very long period of time in which the various species underwent considerable modification. We have therefore published in full Dr. Wortman's field notes upon the geology of the Big Horn and Wind River Basins, as well as geographical details, which will be of great service to collectors in the future (pp. 135–144). We give (p. 83) a preliminary conspectus of the distribution of the species; this cannot be fully made out until all the species are determined by a comparison with Cope's types.

Before taking up the systematic description of the collection, we offer three introductory sections, treating of the structure of the molar teeth, the classification of the Perissodactyla, and the origin of the Felidæ.

I.—Homologies and Nomenclature of the Mammalian Molar Cusps.

In October, 1888, a table of nomenclature for the cusps of the molar teeth of mammalia was published in the 'American Naturalist.'[1] The terms were carefully chosen with reference to the gradual rise of these cusps from the single cone of the reptilian type, through the tritubercular to the sexitubercular stages.[2] They have since been wholly or in part adopted by Cope, Scott, Lydekker, Schlosser,[3] Flower, and lately by Rütimeyer.[4] The tritubercular stem form has been recognized by Döderlein and Fleischmann, but these authors have employed various Greek symbols for the cusps. The latter has opposed the adoption of similar terms for the main cusps of the upper and lower molars, upon the ground that Cope and myself have mistaken the homolo-

[1] Osborn, The Nomenclature of the Mammalian Molar Cusps, op. cit., p. 927.

[2] See also Evolution of Mammalian Molars to and from the Tritubercular Type, Am. Nat., December, 1888.

[3] Schlosser, Die Differenzierung des Säugethiergebisses, Biologisches Centralblatt, Juni, 1890.

[4] Die Eocäne Säugethier-Welt von Egerkingen, Zurich, 1891.

gies; this objection would be fatal to a uniform system of nomenclature for the upper and lower cusps if it could be sustained, but a comprehensive survey of the Mesozoic trituberculates, especially of the Amblotheriidæ and Spalacotheriidæ, leaves no doubt that *the antero-external cusp in the lower molars and the antero-internal cusp in the upper molars of the mammalia are homologous with the reptilian cone and with each other;* these cusps are invariably the most prominent, and are always styliform in primitive types; they always form the apices of the primitive crown; they persist in almost all mammals, while one or all of the later cusps may disappear.

This cardinal point established, it will be a great gain for palæontology and comparative odontology when the further truth is recognized that *the possibilities of modification of type in the molars are limited,* that essentially similar types of teeth are evolved independently over and over again, and that in course of what Schlosser has well termed 'modernization' we find such diverse orders as Primates, Ungulates, Insectivores, Marsupials, Rodents, all exhibiting the same laws of dental modification, and the same or similar 'secondary' cusps, crests and peripheral styles.

Excepting in the Cetacea and Edentata, these modifications centre around the simple tritubercular crown, which seems to possess unlimited capacity of adaptation by the development of some parts and degeneration of others, by changes of form and position, and by the addition of secondary cusps.

The first step is to distinguish and separate clearly the primary and secondary regions of the primitive crown, for originally they have absolutely different functions; the part first developed in both upper and lower molars is the anterior primitive triangle or *trigon,* which has a cutting or piercing function; out of its three cones all 'secodont' types of molars are evolved. The part next developed is the *talon,* or heel, which has a crushing or grinding function, and therefore plays a chief *rôle* in all 'bunodont' types. The first diagram exhibits the relations of these two portions of the crown in the upper and lower molars, and the six primary and secondary cusps which typically develop upon each (Fig. 1).

We will not enter here into the well-understood transformation of this tuberculo-sectorial type into the sexitubercular bunodont

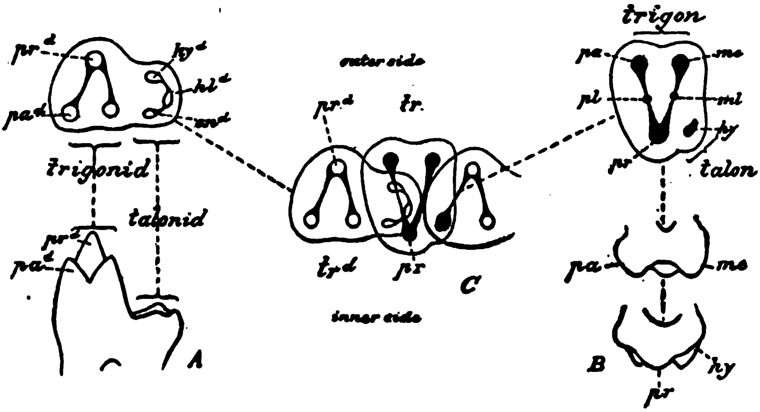

Fig. 1. Diagram of the Tuberculo-Sectorial Stage of Mammalian Molars. *A*, The lower molar, crown and internal view. *B*, The upper molar, crown, internal and external views. *C*, Opposition of upper and lower molars.

type, seen typically in the upper and lower molars of the Puerco *Protogonia*, which is the least specialized ancestral bunodont form that has been discovered. We may lay emphasis upon the fact that the *parent form of ungulate molar has six tubercles* both above and below instead of six above and four below as formerly supposed.

It is important to remember, as an exception to the law of sexitubercular origin, that all the Amblypoda and all the Periptychidæ[1] (among the Condylarthra) developed their upper molars upon the trigonal basis, out of the three tubercles of the tritubercular crown, and without becoming sexitubercular, that is, without the addition of the hypocone or talon.

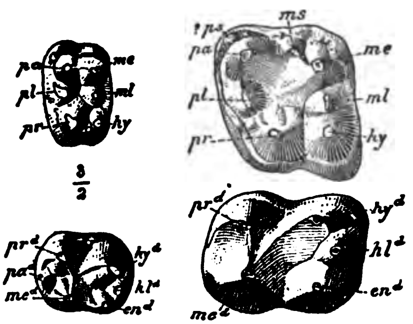

Fig. 2. The Primary Cusps of an Ungulate (Perissodactyl-Artiodactyl) Molar, *Protogonia puercensis*, and of the Condylarth, *Phenacodus primævus*. (For abbreviations, see table, page 91.)

Now how shall we study the molar teeth of the early Ungulates, especially of the apparently

[1] There are considerable grounds for removing the Periptychidæ from the Condylarthra to the Amblypoda.—O.

similar primitive forms of Perissodactyls, which are so difficult to distinguish? The following steps must be taken:

First.—Locate each of the six primary and secondary cusps, as far as they are present.

Second.—Note the *form* of each, whether rounded (bunoid), crested (lophoid), or crescentic (selenoid).

Third.—Note the *position* of each upon the crown with relation to the other cusps.

Fourth.—Note the *relative size* or development of each.

Fifth.—Note the relative development of the *cingulum*, in different parts of the contour.

Sixth.—Note the presence of one or more *peripheral secondary cusps*, which develop from the cingulum, or external borders of the crown.

Finally.—If *crests* are formed or forming, note the points at which the transverse crests unite with the external cusps (paracone and metacone, parastyle and mesostyle).

These differential features, it will be observed, follow the progressive order of evolution in the molar crowns, for in 'modernization' we see, first, a *degeneration* of one or more of the primary cusps, then a *remodelling* of the form of each cusp which may affect the twelve upper and lower cusps very differently: for example, in such an ancient type as *Meniscotherium* we find one bunoid, two lophoid, and three selenoid cusps in each of the upper molars. Third, the cusps begin to shift their positions upon the crown. Fourth, they begin to develop unequally. Fifth, the cingulum, which is primitively a complete peripheral band, begins to disappear at certain points. Sixth, one or more peripheral cusps grow up from the cingulum or upon the sides of the main cusps. Finally, as the crests develop, the unequal development of the cusps causes the transverse crests to unite at different points with the external crest.

We find that if such analysis be applied to the elements of the molar teeth we derive an absolutely infallible means of distinguishing different lines of descent, for the above are the main features of divergent evolution.

The primitive horse, tapir, rhinoceros and titanothere all stand apart and cannot be confused; each have their clear differentia. To check the possibility of being misled by *parallelism* in molar form, we should next observe the dental series as a whole, the proportionate development of different members of the series—the *metatrophism*; this often furnishes the final proof or disproof of relationship, so far at least as can be derived from the dentition alone.

The above method of analysis is the outgrowth of an extremely careful study and comparison of all the early Condylarthra and Perissodactyla, and it has been found necessary to exercise the closest scrutiny to distinguish these early stages of divergence.

Now to turn to the subject of nomenclature, the system of terms was originally based upon the actual homologies of the primary elements of the trigon and trigonid, but in extending it to the other parts of the crown and to the secondary cusps it was found that we must apply similar terms to some of the later elements in the upper and lower teeth, which are merely analogous to each other (performing a similar function, occupying a similar position, and developing at about the same period), otherwise the terms soon multiply so as to become a burden rather than a convenience.

As far as possible, therefore, the same prefixes are retained for the secondary parts of the molars as for the primary; thus the anterior transverse crest of the upper molars is called the *protoloph*, as it is invariably developed by the union of the protocone, protoconule and paracone or parastyle, never from the metacone. The anterior transverse crest of the lower molars is termed the *metalophid* because it is always developed from the metaconid or metastyle, and protoconid, never from the paraconid; the posterior transverse crest of the lower molars is termed the *hypolophid*, because it is mainly formed by the hypoconid and entoconid, never from the metaconid or paraconid. The external crest of the upper molars is composed of so many cusps that it requires a distinct prefix, but is readily remembered as the *ectoloph*. So with the peripheral cusps, one or more of which are developed in all Ungulates, and are especially numerous in molars of the Equidæ; to these the terminal *-style* is applied in lieu of the English term 'pillar' proposed by Huxley—we can readily locate the *parastyle* as the antero-external buttress which is developed near the paracone, the *mesostyle* as developed on the outer wall between the paracone and metacone. Similarly, in the lower molars, we find in several lines of Ungulates, but again most conspicuously in the Equidæ, that the metaconid and entoconid are reinforced by little cusps which grow up behind them (*a*, *a* and *b*, *b*, Rütimeyer); these may be termed respectively the *metastylid* and *entostylid*, while the pillar arising secondarily in the primitive position of the paraconid may be termed the *parastylid.*

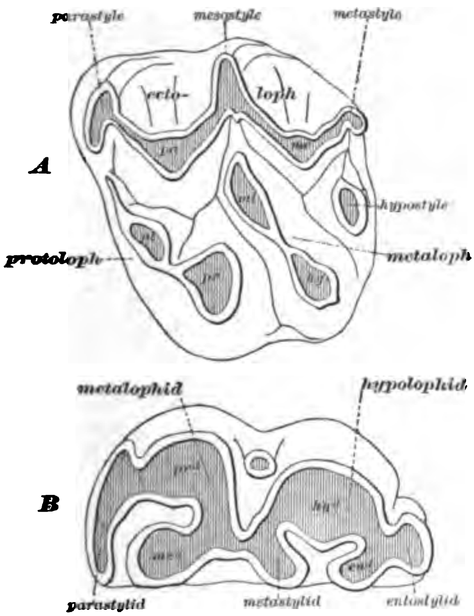

Fig. 3. The Secondary Cusps of an Ungulate Molar. *A*, *Anchitherium*, upper. *B*, *Merychippus*, lower. The Primary Cusps are indicated by abbreviations.

The principles upon which this terminology is based are therefore very simple.

1. The termination *-cone* is given to the main primary or central cusps, and *-conule* to all intermediate cusps.

2. The termination *-style* is proposed for the peripheral cusps arising mainly from the cingulum.

3. The termination- *loph* is applied to the crests.

4. The seven prefixes are based upon the succession and position of the elements in the primitive evolution of the crown, viz.:

proto-, *para-*, *meta-*, *hypo-*, *ento-*, *ecto-*, *meso-*. The prefixes are first applied to the cones; then to the styles, according to their proximity to the cones; then to the crests, according to the cones which mainly compose them.

5. Homologous and analogous elements in the upper and lower jaws are given similar terms, but distinguished arbitrarily by the terminal *-id*.

Upon the opposite page are given the terms formerly employed by French, German and English authors for the teeth of the Ungulates before their common tritubercular origin had been discovered by Cope. In his 'Enchainements du Monde Animal' Professor Gaudry, as far back as 1878, worked out most clearly the homologies of the molar elements in the Ungulates from the sexitubercular-quadritubercular stage onwards; the valuable earlier studies of Rütimeyer[1] are well known. But now that the ungulate molar has been found to converge to the unguiculate molar type, and both are found to contain the same elements, and to spring from the same mesozoic source, it is important to unify our methods of description by adopting a set of terms which refer back to the primitive form and position in place of those which were based upon the comparatively modern form and position.

II.—The Classification of the Perissodactyla.

In this paper a departure from the current system of classification of the fossil Ungulates is adopted—the early members of each of the great families of Perissodactyla are placed in subfamilies under the most recent family names, Equidæ, Rhinocerotidæ, Titanotheriidæ, etc.

The main desiderata of classification are: first, clearness in the expression of phyletic relationships; and second, convenience. Neither is attained when we place the well-determined ancestors of existing or of recently extinct families in separate families founded upon the similar transition characters of ancestral types. We have elsewhere[2] protested against the principles of family

[1] Beiträge zur Kenntniss der fossilen Pferde, Berlin, 1863.

[2] See Osborn, The Mammalia of the Uinta Formation, pp. 550, 536 (footnotes).

TERMINOLOGY OF THE PRIMARY AND SECONDARY ELEMENTS OF MAMMALIAN MOLAR TEETH.

	GAUDRY, FILHOL, French authors.	RÜTIMEYER, KOWALEVSKY, German authors.	HUXLEY, FLOWER, LYDEKKER. English and American authors.	Terms based upon primitive homologies.	Abbr.
PRIMARY CUSPS.					
Upper Molars.....	denticule interne du premier lobe.	innenpfeiler des vorjochs.. (innern Hauptgipfeln.)	antero-internal, anterior pillar....	protocone	pr
	" externe " "		antero-external, anterior crescent..	paracone	pa
	" " second "	....	postero- " posterior " ..	metacone	me
	" médian premier "	zwischen gipfel, tuberkel..	antero-intermediate tubercle	protoconule	pl
	" " second "	" " "	postero- " "	metaconule	ml
	" interne " "	innenpfeiler des nachjochs. (innern Hauptgipfeln.)	postero-internal, posterior pillar..	hypocone	hy
Lower Molars.....	" externe du premier "	....	antero-external cusp............	protoconid	pr^d
	" (interne antérieure) "	....	" internal, fifth cusp.......	paraconid	pa^d
	" " du premier "	....	" internal cusp............	metaconid	me^d
	" externe du second "	....	postero-external "	hypoconid	hy^d
	" interne " "	....	" internal "	entoconid	en^d
	" médian " "	....	postero-median, third lobe.......	hypoconulid	hl^d
CRESTS.					
Upper Molars.....	.... crête externe......	aussenwand	external crest, dorsum.	ectoloph	
	premier lobe, crête antérieure....	vorjoch................	anterior crest, or collis..........	protoloph	
	second lobe, crête postérieure ..	nachjoch...............	posterior " "	metaloph	
Lower Molars.....	premier lobe, crête antérieure	vorjoch	anterior crest.................	metalophid	
	second lobe, crête postérieure ..	nachjoch...............	posterior "	hypolophid	
	....	schlussjoch............	third lobe....................	hypoconulid	
PERIPHERAL CUSPS.					
Upper Molars.....	....	pericones, Randgipfeln....	anterior buttress, ridge, costa....	parastyle	ps
	....	" "	median " "	mesostyle	ms
	....	" "	posterior " "	metastyle	mts
	....	....	" prominence, pillar......	hypostyle	hs
Lower Molars.....	....	....	reduplication of metaconid......	metastylid	mts^d
	....	....	" " entoconid	entostylid	es^d

PRIMARY AND SECONDARY DIVISIONS OF CROWN.

Primitive triangle, Anterior portion of crown. { *Upper Molars*. Trigon (protocone, paracone, metacone). { *Lower* " Trigonid " " "

Secondary talon, heel, Post. portion of crown. { *Upper Molars*. Talon (hypocone). { *Lower* " Talonid (hypoconid, entoconid, hypoconulid).

division adopted by Cope and Lydekker, especially against the meaningless term *Lophiodontidæ.* Why not place an ancestral horse among the Equidæ, instead of terming it a 'lophiodont,' especially when we are at present ignorant what the Lophiodontidæ were? Formerly there may have been some ground for the use of the latter family in a vague comprehensive sense to embrace Perissodactyls in a common stage of premolar evolution (*i. e.*, premolars simpler than molars), but this ground has been wholly removed by the discovery that even in the Wahsatch period the horses, tapirs, titanotheres, hyracodonts, rhinoceroses and other series were clearly separated from each other, either by well-marked structural characters in the teeth and feet or by well-defined developmental tendencies. If we embrace primitive horses, tapirs and rhinoceroses in the Lophiodontidæ on the ground that the premolars in these animals are unlike the molars, we practically raise this *family* to the rank of an *order*, and, moreover, find it impossible to define it, for we thus confuse a merely similar stage of evolution with a similarity of descent.

Schlosser, with whose ideas about classification we thoroughly agree, has taken the other extreme, and placed all the extinct forms under the recent families;[1] this is a far clearer method, but it is even preferable to group earlier and collateral forms under subfamily names.

By such an arrangement of the Perissodactyla we pass from one extreme to the other in the types of transformation of the molars. We give chief weight to tooth structure, as for example in separating the *Helaletes* from the *Hyrachyus* series, and secondly to foot structure, as for example in the doubtful separation of the *Palaplotherium* (monodactyl tendency) from the *Palæotherium* (typical tridactyl) series. The position of the Amynodontidæ[2] will remain somewhat uncertain until we ascertain the foot structure; the tooth structure is intermediate between that of *Hyrachyus* and *Rhinocerus.* The position of the Lophiodontidæ is also uncertain; the Lophiodons are not, as generally supposed, related to the Tapirs, and until we ascertain the skull and foot structure

[1] Beiträge zur Stammesgeschichte der Hufthiere.... Morph. Jahrbuch, Bd. XII.

[2] This family was defined by Osborn, Mammalia of the Uinta Formation, p. 507.

Molar Type.	Family.	Eocene, Miocene or Pliocene.	Subfamily.	Premolar. Metamorphosis.	Brachydont or Hypsodont.	No. of Digits.	Earliest Genus.	Latest Genus.
Buno-Selenodont ...	I. Titanotheriidæ..	E.	Palæosyopinæ......	p. < m.	Br.	4-3	Palæosyops.....	Diplacodon.
		M.	Titanotheriinæ...	p. = m.	"	4-3	Titanotherium..	o
Lopho-Selenodont.. (*Equine.*)	II. Equidæ........	E.	Hyracotheriinæ ..	p. < m.	"	4-3	Hyracotherium	Epihippus.
		M.	Anchitheriinæ....	p. = m.	"	3-3	Mesohippus....	Merychippus.
		P.	Equinæ.........	p. = m.	Hy.	1-1	Protohippus....	Equus.
	III. Palæotheriidæ...	E.	Palaplotheriinæ ..	p. < m.	Br.	? 3-3	Propalæotherium	Palaplotherium.
		E.	Palæotheriinæ	p. = m.	"	3-3	Palæotherium...	o
Sub-Lophodont..... (*Tapirine.*)	IV. Tapiridæ	E.	Systemodontinæ..	p. < m.	"	? 4-3	Systemodon....	Isectolophus.
		M.	Tapirinæ........	p. = m.	"	4-3	Protapirus......	Tapirus.
Transitional.......	V. Helaletidæ.....	E.	Helaletinæ	p. < m.	"	4-3	Heptodon	Helaletes.
	VI. Lophiodontidæ.	E.	Lophiodontinæ ..	p. < m.	"	? 3-3	x	Lophiodon.
Lophodont......... (*Rhinocerotine.*)	VII. Hyracodontidæ.	E.	Hyrachyinæ	p. < m.	"	4-3	x	Hyrachyus.
		M.	Hyracodontinæ ..	p. = m.	"	3-3	Hyracodon.....	o
		E.	Triplopodinæ	p. < m.	"	3-3	x	Triplopus.
	VIII. Amynodontidæ.	E.	Amynodontinæ...	p. < m.	"	?	x	Amynodon.
		M.	....	p. = m.	"	......	Metamynodon ..	o
	IX. Rhinocerotidæ..	M.	Aceratheriinæ	p. = m.	"	4-3	Aceratherium ...	Aphelops.
		M.	Diceratheriinæ...	....	"	......	Diceratherium..	o
		P.	Rhinocerotinæ....	p. = m.	"	3-3	x	Rhinocerus.
		P.	Elasmotheriinæ ..	p. = m.	Hy.	......	x	Elasmotherium.

p. < m., premolars simple. p. = m., premolars molariform. Br., brachydont. Hy., Hypsodont. x, Unknown members of series. o, Extinction of subfamily.

they remain problematical; the nearest relatives are the Helaletidæ.

The sub-families of Rhinocerotidæ are equivalent to what Lydekker has called "Aceratherine Group," "Diceratherine Group," etc. As several of these groups contain more than one genus, it appears convenient to raise them to the rank of sub-families. It is evident that the Systemodontinæ and Tapirinæ are very similar in tooth structure, and that their relationship will turn upon the structure of the feet.

III.—The Ancestry of the Felidæ.

The Miocene Cats.—So far there appears to be entire unanimity of opinion in favor of the proposition that the Miocene Nimravidæ stand in direct ancestral relation to the true cats, and while they exhibit a number of primitive characters yet, even at the beginning of the Miocene epoch, they had become sufficiently specialized to present many of the more important characters which now distinguish the modern Felidæ.

There can be little doubt but that the Nimravidæ present many resemblances to the Viverridæ, chiefly through the living genus *Cryptoprocta*, which Mivart refers to this latter family. These resemblances have influenced Scott to believe that the two families have had a common ancestry.[1] Whether this proposition is true or not future discovery must decide.

Some of the more striking characters in which the Nimravidæ resemble the cats most, are seen in the short muzzle in comparison with the skull, the wide zygomata, the divergence of the tooth lines posteriorly, together with the reduction in the molar and premolar dentition. Other characters of importance are the straight transverse line in which the lower incisors are placed, together with those derived from the lower jaw.

The principal characters in which they differ from the true cats are to be found in the foramina at the base of the skull, the possession generally of a second lower molăr, the greater size and less internal position of the single upper molar, the presence of a distinct talon, and the frequent appearance of an internal

[1] Proc. Acad. Nat. Sci. Phila., 1889, p. 242.

tubercle upon the lower sectorial. The superior sectorial is, moreover, less perfect in generally lacking the third lobe or anterior cutting blade, while the premolar formula as a rule is less reduced. To these must be added other characters derived from the skeleton (Fig. 5, *B*).

It is to be borne in mind that these generalized Nimravine forms made their appearance in the oldest Miocene deposits of this country and probably at an earlier date in Europe, if we consider the Phosphorites of France to belong to the upper Eocene, as is done by some palæontologists, so that their ancestry must be sought for in formations older than this horizon. The fact that no representatives of the Viverridæ have yet been found in this country militates against the view of their origin in America, at least, from this source, although of course it is not impossible that migration may have taken place. The same argument applies to the Creodont *Miacis*, which has thus far been found only in the American Eocene.

Relations of the Creodonts to the Felidæ.—Schlosser has maintained that the feline phylum has been derived independently from the Creodonts.[1] Cope formerly held a similar view,[2] deriving the Felidæ directly from *Oxyæna*. Later he has changed his mind and now considers all the Carnivora as direct decendants of the Miacidæ.[3] Scott has expressed a similar view[4] and derives the Nimravidæ, which in turn gave rise to the Felidæ, directly from the Miacidæ.

With reference to the *direct* origin of the Nimravidæ *from any known Creodont*, the evidence heretofore has, however, been so meagre as to compel both Cope and Scott to reject the hypothesis as altogether conjectural.

Scott, in his excellent memoir already cited, observes: "No known group of Creodonts can be selected as having any *close* relations to the cats. The Oxyænas, it is true, do exhibit surprising analogies with this recent family, but the analogy is con-

[1] Ueber die Beziehungen ausgestorbenen Säugetierfaunen und ihr Verhaltnisse zur Säugetierfauna der Gegenwart. Biologisches Centralblatt, Bd. VIII.

[2] Tertiary Vertebrata, p. 264.

[3] The Creodonta. American Naturalist, March, 1884, p. 261.

[4] Notes on the Osteology and Systematic Position of Dinictis felina, Leidy. Proc. Acad. Nat. Sci., Phila., July 30, 1889, p. 242.

fined to the teeth, and is only superficial, *as the teeth, which in the two groups look so much alike, are not homologous*, and are developed in quite a different way." While this objection holds true of *Oxyæna* it does not necessarily apply to all the Creodonta, and if it can be shown that there is an Eocene genus of Creodonts, which fulfills the necessary requirements, then in our judgment it becomes equally, if not more probable that the ancestry of the Nimravidæ is to be referred to it, rather than to any group which has not been shown as yet to precede it in time.

Judging from the tooth and skull structure of the Nimravidæ, what characters would one be led to look for in their ancestors? We would say that in the upper jaw there should be a short muzzle, well-developed canines, a wide palate posteriorly, rapidly diverging tooth lines, marked tendency to molar reduction, and a large infraorbital foramen. In the lower jaw there should be a moderately deep ramus, straight upon its lower border, a flattened, truncated symphysis, an inferior dental foramen placed well below the tooth line, a distinct scroll-like condylar facet and a reduced second true molar.

Palæonictis and the Felidæ.—These conditions we have fulfilled completely in the genus *Palæonictis;* the muzzle is short and the infraorbital foramen large, reminding one at once of *Dinictis*. The palate is relatively short and broad posteriorly; the second upper molar *(m 2)*, although present, is reduced quite as much as is the first true molar of the existing cats, having but a single root and a degenerate crown. The fourth superior premolar, while it does not display the perfect blades of the well-developed sectorial, nevertheless possesses the required primitive elements from which this tooth has been developed. The blades of the inferior sectorial *(pr^d and pa^d)* produce a distinct 'shear' against the posterior and outer median cusps, as is demonstrated by the increased wear at this point. (See Fig. 5 *F*, and Plate IV.)

In the lower jaw we note the deep ramus with the comparatively straight inferior border; the inferior dental foramen is situated well below the tooth line, the symphyseal region is relatively broad and truncated, and the condylar facet has the distinctively scroll-like pattern seen in the cats. The second true molar is reduced in size, smaller than the sectorial, while the sectorial itself has a relatively large talon and internal tubercle. The two blades of the sectorial are comparatively little developed, and they occupy a position at a considerable angle to the long axis of the jaw. The internal and external tubercles of the anterior triangle form a subsidiary blade which shears against the anterior edge of the internal tubercle of the first upper true molar, as is demonstrated by the wear exhibited in this situation.

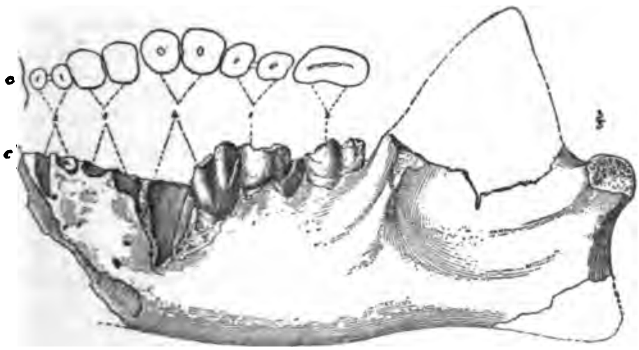

Fig. 4. *Patriofelis ulta*, type specimen, National Museum. External view of left lower ramus. Alveoli of teeth from above. Three-fifths natural size.

Patriofelis ulta *Leidy.*

As will be noted, *Palæonictis* has been found thus far only in the lower Eocene (Wahsatch and Suessonian), and before we are able to establish a connection with the Miocene forms it is necessary to know something of its successors in the Wind River and Bridger formations which lie intermediate. The only specimens known to us from the Bridger which can be related to *Palæonictis* are the type of *Patriofelis* Leidy, and an undescribed jaw in the Princeton Collection which Professor Scott has kindly placed at our disposal.

We may first consider the former. As shown in Fig. 4, and described by Leidy, the inferior dentition of *P. ulta* is probably p=3, m=2. The fourth premolar is the best preserved tooth; it is relatively larger than the first true molar, judging by the proportionate measurement of the fangs. The outer face of the crown and the characters of the deuterocone, or posterior basal cusp, are closely similar to the corresponding parts in *Palæonictis* and *Ambloctonus*. The first true molar of the *Patriofelis* type is badly broken. The second true molar is proportionately larger than in *Palæonictis*.

? **Patriofelis leidyanus,** sp. nov.

The Princeton specimen (Fig. 5, *C*,) may be provisionally referred to the same genus, and distinguished as *P. leidyanus*. The specific character is that the fourth lower premolar is smaller than the first true molar. It carries the third and fourth premolars together with the first molar or sectorial. It also bears distinct traces of the canine alveolus, which serves to demonstrate *that the complete jaw contained but three premolars*, the first of which was probably small and single rooted. The length of the tooth line indicates that the jaw was short, resembling in this respect some of the modern cats. The principal interest, however, centers in the first true molar, or sectorial, in which we observe all the elements of the corresponding tooth in the most generalized forms of the Nimravidæ, but also just such an advance over the sectorial of *Palæonictis* as the sectorial of *Felis* advances beyond that of *Dinictis*. In this specimen we note that the two blades are much better developed than in *Palæonictis*, and occupy a position almost if not quite parallel with the long axis of the jaw. The internal tubercle and talon are much reduced. The posterior faces of the external and internal tubercles are rounded, not flattened as in *Palæonictis*, and there is no evidence of a secondary shear between this part of the tooth and the anterior edge of the internal lobe of the first upper true molar, which would have undoubtedly been the case if this part of the upper tooth had been well developed.

This evidence leads indirectly to the supposition that the first upper molar was considerably reduced, which in turn would seem to justify the inference that the last upper molar had completely disappeared. While this view is of course inferential, it is nevertheless strongly suggested by what we know of other forms, as, for example, *Amblyctonus*. The points of wear in one series and a knowledge of the lobes and cusps which produce it

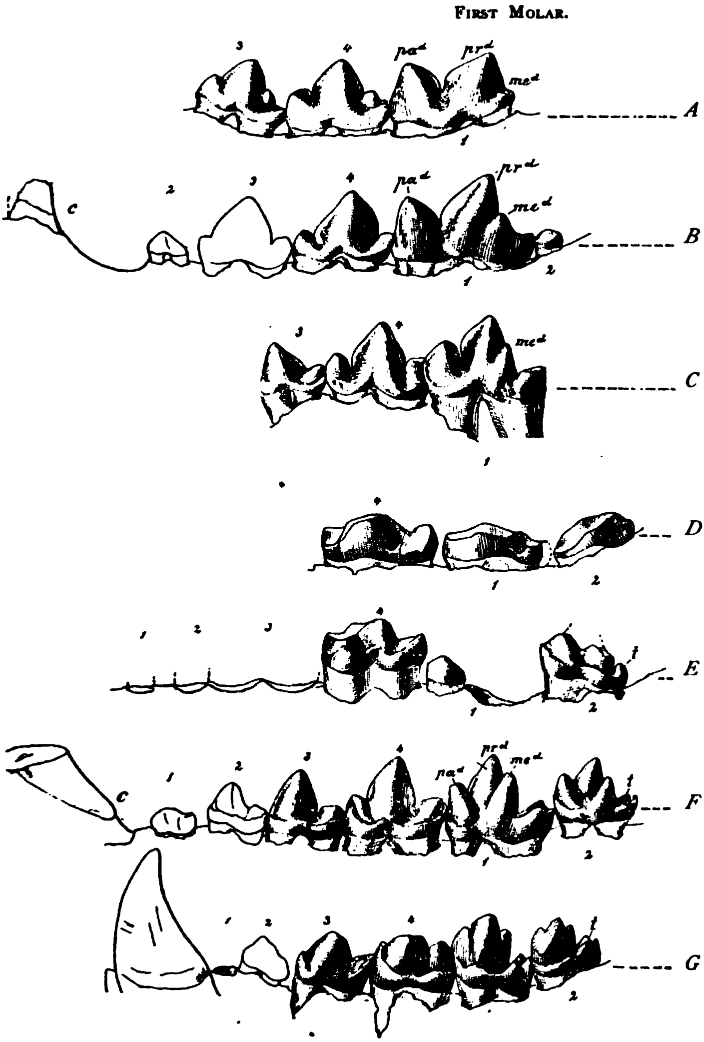

Fig. 5. Series of types showing (1) the evolution of the Sectorial Molar; (2) the reduction of the *Talon*, *t*, of the second molar in the *Palæonictidæ*. All figures natural size.

A. Felis concolor (inner view).
B. Dinictis felina "
C. ? Patriofelis leidyanus "
D. Ambloctonus (outer view).
E. Ambloctonus sinosus (inner view).
F. Palæonictis occidentalis "
G. Palæonictis gigantea (outer view).

in the other, is of the utmost importance in determining the relationship between the upper and lower teeth. This is of all the greater moment when we have to deal with a rapidly degenerating series of teeth, as we do in the present instance. When the complete dentition of this interesting form is known, we are induced to predict from the evidence already cited that it will be found to have but a single upper true molar much better developed than in any of the Nimravidæ at present known, that there will be found to be two true molars in the lower jaw, with the last one intermediate between the conditions now exhibited by *Dinictis* and *Palæonictis*, that the premolars will be three in the lower and three or four in the upper jaw, and that altogether it will display marked affinities in the direction of the Nimravidæ.

CONCLUSIONS.—The evidence which we here present in favor of the derivation of the cats from the Palæonictidæ is based solely upon a consideration of the teeth and of the form, so far as we can judge, of the jaws, but it may transpire that when the skeleton of *Palæonictis* is discovered there will be difficulties presented which will invalidate this evidence; and before we are in possession of such facts any final judgment in the matter must be regarded as premature. However, we have deemed the matter of sufficient importance to discuss it thus fully. The evidence may be summed up as follows:

In favor of this genetic relationship:

1. *Palæonictis* presents the same mode of dental reduction as the Nimravidæ and Felidæ, namely: rapid loss of the posterior pair of upper and lower molars and of the anterior premolars.
2. It presents the same sectorials as the Felidæ, namely: the fourth upper premolar and first lower molar.
3. It presents the feline conformation of the skull.

Against this relationship:

1. *Palæonictis* and *Patriofelis* (*ulta*) show an enlargement of the fourth lower premolar not observed in the Felidæ.
2. The evidence rests solely upon the teeth, as the foot structure and skeleton of *Palæonictis* is unknown.

A conservative conclusion based upon our present evidence is that the *Palæonictidæ were a family of Creodonts from which the Felidæ may have sprung.* No other known Creodonts present so many points of resemblance with the cats, or the possibilities of such derivation.

The mode of dental reduction, the homologies of the lower molar cusps, showing the rise of the sectorial by the development of the paraconid and protoconid, are beautifully shown in the above series of figures. (Fig. 5, *A–G.*)

IV.—Taxonomy and Morphology of the Primates, Creodonts and Ungulates.

1.—Wahsatch Fauna.

Order PRIMATES.

The collection is very rich in the Lower Eocene Monkeys, containing four specimens of *Anaptomorphus*, forty of *Hyopsodus*, sixteen of *Pelycodus*, two of *Cynodontomys*, and several specimens which cannot be determined.

Classification of the Fossil Primates.—It seems probable that the Anaptomorphidæ belong to the Lemuroidea, although this reference rests merely upon the external position of the lachrymal foramen in the type skull of *Anaptomorphus homunculus*, and we have not at present any means of determining whether the inferior caniniform tooth is a true canine, as in the Anthropoidea, or is a modified first lower premolar as in the typical Lemuroidea.

The other Eocene Monkeys, such as the Adapidæ, the Notharctidæ (= Limnotheridæ, Marsh), and the Microsyopsidæ have also been usually placed in the Lemuroidea, but there is absolutely no ground for this reference; while there are, on the other hand, many reasons to believe that they are primitive Anthropoidea, and that they bear somewhat the same relation to the modern Anthropoidea that the Eocene Perissodactyla bear to the modern

Perissodactyla. At least, there are no means of separating them from this suborder.

Schlosser was the first to unite the Eocene Monkeys of Europe in the 'Anthropomorphæ,' but he has inconsistently separated the American Monkeys as 'Pseudo-lemuroidea,' a division which if valid is preoccupied by the 'Mesodonta' which Cope has abandoned.

Sub-order LEMUROIDEA.

Family ANAPTOMORPHIDÆ *Cope.*

This family is distinguished by its extremely reduced dentition; the premolars are unlike the molars, and are 3–2 in number; there are but two lower incisors, and apparently a true canine; the upper molars are tritubercular; the lower molars are quinquetubercular or quadritubercular.

A comparison of Leidy's type of *Omomys*, from the Middle Eocene (Bridger), with Cope's specimens and those in the American Museum, shows that it probably belongs in this family, although a small second premolar persists as in the Wahsatch species of *Anaptomorphus* (*A. homunculus*), and the chin is more elongate and less rounded than in *A. æmulus* from the Bridger. In every detail of dental structure, excepting the above, *Omomys* closely resembles *Anaptomorphus.*

Genus **Anaptomorphus** *Cope.*

It will be remembered that Cope's type (*A. æmulus*) of this genus is a lower jaw with the formula I $_2$, C $_1$, P $_3$, M $_3$. He subsequently referred to the same genus the species *A. homunculus*, founded upon a skull (without the jaws) from the Wahsatch. It is interesting to record the discovery of a specimen from the Wahsatch in which a nearly complete lower jaw is associated with upper teeth identical with those of *A. homunculus.*

Anaptomorphus homunculus *Cope.*

The best specimen (No. 41) consists of portions of the two maxillæ containing two premolars and three molars, and of a lower jaw containing the corresponding teeth.

As might have been anticipated, the inferior true molars are in a slightly earlier stage of evolution than those in the Bridger species. Cope has described the molars of *A. æmulus* as "quadritubercular," but more strictly speaking, the first and second molars are quinquetubercular, for they display rudiments of the fifth tubercle or paraconid, and are transitional. In the jaw of *A. homunculus* we find the paraconid more distinct upon the first true molar, and gradually decreasing in size upon the second and third. The third and fourth premolars are similar to those in *A. æmulus*, but the internal cuspule is not visible upon the fourth.

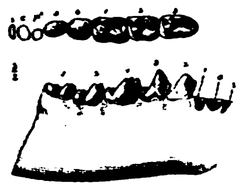

Fig. 6. *Anaptomorphus homunculus*: external view of lower jaw and crown view of teeth. 1½ natural size.

A more important primitive character is indicated by a very small alveolus for the root of a *second premolar* upon the outer side of the jaw, so that the formula of this species should probably be written: Premolars, $\frac{{}^{1}2}{3}$. Molars, $\frac{3}{3}$ = *A. homunculus*. We cannot determine whether there is also a trace of the second premolar in the maxilla. Three other specimens (Nos. 42, 43, 44) may be similarly referred.

Order CREODONTA *Cope*.

This order is represented in the collection by specimens belonging to all the known Wahsatch families, namely the new family Palæonictidæ, the Oxyænidæ, the Miacidæ, the Proviverridæ, the Mesonychidæ and the Arctocyonidæ.

Family PALÆONICTIDÆ.

The material at our disposal indicates that *Palæonictis* belongs to a distinct family of Creodonts. Cope has in fact placed it with *Ambloctonus* in the Ambloctonidæ, although he misinterpreted the dental formula of *Ambloctonus*, owing to the extremely fragmentary condition of the type.

It is important to distinguish these forms clearly from the Oxyænidæ, with which they present a superficial resemblance.

Palæonictidæ.

Face short. Fourth upper premolar and first lower molar, only, developing into sectorial. Dental reduction the same as in Felidæ (*i.e.*, m. $\frac{2}{2}$ and $\frac{3}{3}$ disappear).

Oxyænidæ.

Face long. Fourth upper premolar and first upper molar, first and second lower molars developing into sectorials. Dental reduction unlike that in Felidæ (*i.e.*, m. $\frac{3}{3}$ disappear).

The Palæonictidæ are distinguished readily from the Proviverridæ (to which the contemporary *Stypolophus* belongs) by the extreme reduction of the upper and lower true molars.

Family *Palæonictidæ.*

Palæonictis: I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{2}{2}$. Second upper molar very small. Second lower molar with well-developed talon. First lower molar tuberculo-sectorial.

Ambloctonus: I ?, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{1}{2}$. Second upper molar absent. Second lower molar with talon rudimentary or wanting.

Patriofelis: I ?, C $\frac{1}{1}$, P$\frac{3}{4}$, M $\frac{1}{2}$. (First lower molar sub-sectorial.)

Genus **Palæonictis** *De Blainville.*

P. gigantea De Blainville. Talon of second lower molar long, with three cusps. (Suessonian of France.)

P. occidentalis, sp. nov. Talon of second lower molar short, with a single cusp. (Wahsatch of America.)

Genus **Ambloctonus** *Cope.*

A. sinosus Cope. Talon of second lower molar wanting, or reduced to a spur. (Wahsatch.)

Genus **Patriofelis** *Leidy.*

P. ulta Leidy. Fourth lower premolar larger than first molar.

P. leidyanus, sp. nov. Fourth lower premolar smaller than first molar.

Palæonictis occidentalis, sp. nov.

Plate IV.

It is important to establish at the outset the generic status of the type specimen. Its reference to *Palæonictis* rests upon the absolute similarity of detail in the structure of the lower teeth with those of De Blainville's types, which are two fragmentary lower jaws containing the third and fourth premolars and two molars. The specific distinction of *P. occidentalis* is the degeneration of the talon of the second lower molar. *Ambloctonus* is very close to *Palæonictis*, if not actually identical, but it may for the present be distinguished by the presence of but one upper molar. (See Fig. 5, *D*, *E*, *F*, *G*. Also Fig. 8.)

The skull of the type (No. 110) of this species has been described under Section III, page 96. The dentition is that of a young individual, and is beautifully preserved. Both of the rudimentary second upper molars were procured, but one of them was unfortunately lost. No other remains were found. All the characters of the skull and teeth are brought out in the lithographic plate.

The animal was one-fourth larger than the American Puma (*Felis concolor*), and slightly larger than either of the specimens referred to *Palæonictis gigantea* by De Blainville and Gaudry. As in *F. concolor* the lower *incisors* are of nearly equal size; while the upper increase rapidly outwards, the first being very small and the third being large and caniniform. The canines are large, vertically striated and recurved; they exhibit an internal ridge extending from the posterior base to the apex.

Lower Series.—The first lower premolar is low and obtuse with a distinct talon. The second has a pointed protocone, a more elevated talon, and a faint external cingulum. The third has a higher protocone, a prominent basal cusp, and distinct external and internal cingula. The fourth premolar is tricuspid, and exhibits a cusp analogous to the paracone (tetartocone, Scott); also the more elevated basal cusp, rising from the talon and analogous to the hypoconid (=deuteroconid, Scott). The cingulum completely encircles the crown, except at the ends, and upon the inner side of the talon is marked by a little tubercle. The first true molar is a fine example of the typical "tuberculo-sectorial" type. The elevated trigonid supports the lofty protoconid and subequal para- and metaconids, while the talon supports three subequal cusps, the hypoconid, the hypoconulid or posterior intermediate cusp, and the entoconid. The second molar is of much smaller size; the trigon bears a reduced metaconid, while the talon is still more reduced by the loss of the two internal cusps, the hypoconid alone persisting.

Upper Series.—The first upper premolar is small and single fanged, with a minute basal cusp. The second has quite a prominent basal cusp with a faint external and an internal cingulum shelf. The third premolar has almost a blade or shear formed by the protocone and deuterocone or basal cusp, and a crenate cingulum shelf. The fourth premolar is, we believe, the incipient sectorial; it has the three external cusps which compose the upper sectorial of *Felis*, but the middle cusp, or protocone, is much the most prominent; this with the posterior cusp (deuterocone) forms a sharp-edged shear, against which abuts the shear formed by the paraconid and metaconid of the first lower molar. Herein lies a close resemblance to the relations of these two teeth in the Felidæ, and these molars furnish a simple key to the feline sectorials, as shown in the accompanying diagrams. (Fig. 7.)

The transformation of the feline upper premolar has taken place by the subequal development, *A*, *B*, of the three external cusps, *te*, *pr*, and *de*, and by the shifting forward of the internal cusp *tr*. Meanwhile the lower molar *has lost the entire talon* (hy^d, hl^d, en^d) *and the metaconid* (me^d) *is reduced to a* rudimentary stage in which it is barely perceptible. This conforms with the description of this transformation given by Cope,[1] but adds a more exact statement of the homologies of the cusps. The degeneration of the metaconid is well shown in the series of sectorials exhibited in Fig. 5.

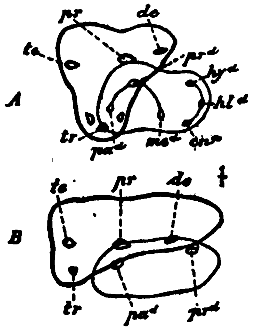

Fig. 7. The homologies of the Molar Cusps in the Felidæ. *A*, *Palæonictis occidentalis*. *B*, *Felis concolor*. *de*, deuterocone. *tr*, trittocone. *te*, tetartocone. Last upper premolar and first lower molar in opposition.

The reduced condition of the upper true molars of *Palæonictis* is most remarkable in an animal of such an early period as the Wahsatch. The third molar has disappeared entirely, the second has been reduced to an extremely small rounded tooth; the first molar is already smaller than the fourth premolar. The pattern of the first upper molar is somewhat similar to that of *Oxyæna*, but the protocone is directly internal instead of being pushed forwards; the external cusps, paracone and metacone, are subequal and slightly compressed; on the trigon between these high cusps and the low protocone are small intermediate tubercles, *pl.* and *ml.* There is a prominent cingulum and a posterior basal cusp.

Ambloctonus sinosus *Cope.*

The skull of *Palæonictis* renders a great indirect service in enabling us to clear up the structure of the enigmatical *Ambloctonus*. This was established upon a much fractured maxilla and mandible, by which Cope was wholly misled as to the notation and homologies of the teeth and the relationships of the genus, although in the 'Tertiary Vertebrata' he placed it near *Palæo-*

[1] The mechanical causes of the development of the Hard Parts of the Mammalia. Journal of Morphology, Vol. III, 1889, p. 232.

nictis. Schlosser has rightly discerned the resemblance between these forms.

The accompanying figure presents our interpretation of this fractured type. There are two lower molars and but a single upper molar ; the maxilla turns sharply in behind the first molar,

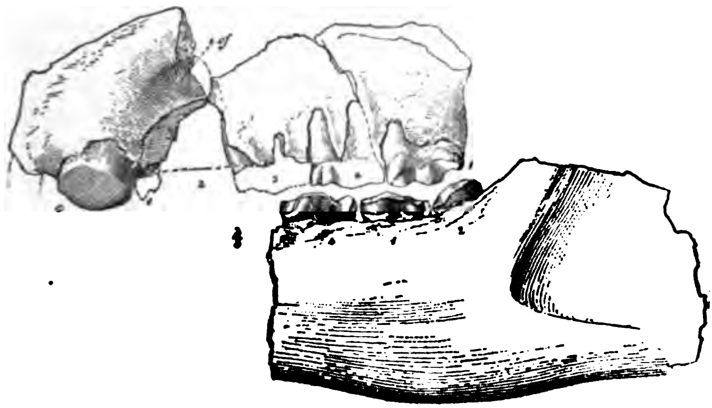

Fig. 8. *Amblyctonus sinosus*, type specimen, National Museum. This drawing is a composition of the left mandible and right maxilla of the same individual. Three-fifths natural size.

and leaves no doubt as to the absence of both the second and third upper molars. The gap between the fourth premolar and first molar does not contain an extra tooth, as Cope supposed. The tooth Cope mistook for the first molar is really the fourth premolar; the gap in the jaw closes up when the matrix is removed. The superior formula was therefore undoubtedly p=4, m=1.

This interpretation is supported by the structure of the lower molars, *i.e.*, by the marked degeneration of the talon of *m2* which it is obvious has nothing to abut against in the upper jaw. Two stages in the reduction of this talon are shown in Fig. 5; in the type specimen *D*, there is no talon ; in a second specimen, rightly associated with the genus by Cope (see Fig. 5, *E*), there is a rudimentary talon, *t*.

Family OXYÆNIDÆ *Cope.*

This family is represented in the collection by eight specimens belonging to the two well-known Wahsatch species, *O. lupina* and *O. forcipata.*

Genus **Oxyæna** *Cope.*

They enable us to add several important family and generic characters. Cope has defined the genus as probably possessing no inferior incisors. (1) We find that there are three incisors in both the upper and lower jaws, as in *Palæonictis.* (2) A tarsus of *P. forcipata* in the collection does not support Cope's view that there was a cleft between the third and fourth digits. (3) There is an os-centrale in the carpus. (4) The lumbar vertebræ have involuted zygapophyses. (5) The femur has a faint rugosity representing the third trochanter.

Oxyæna lupina *Cope.*

We have referred to this species portions of three lower jaws (Nos. 102, 103, 104), and a fragmentary lower molar (No. 105); also the fairly complete skeleton and teeth of a single individual (No. 107).

The Manus of Oxyæna.—As noted by Cope, the skeleton of *Oxyæna* is much smaller and lighter in proportion to the skull than in the Carnivora.

The scaphoid rests upon the trapezium, trapezoid (which is the only carpal missing), and centrale. It is entirely distinct from the lunar. The lunar rests inferiorly, by nearly subequal facets, upon the centrale and unciform, with a narrow anterior and broad posterior contact with the magnum. The cuneiform rests upon the oblique outer surface of the unciform. The trapezium is depressed so as to form a lateral internal support for the second digit. The magnum presents a subquadrate anterior outline. The unciform has an internal contact with the middle digit, and an oblique external facet for the fifth. The metapodials are much shorter, more spreading, and less firmly interlocking than in the Felidæ.

Skeleton of the Limbs and Arches.—The humerus has a very prominent deltoid ridge, and an entepicondylar foramen ; the trochlea presents, anteriorly, subequal faces for the radius and ulna. The ulna presents, distally, two facets—one for the radius, the other for the cuneiform. The femur presents a pit for the round ligament, a prominent lesser trochanter, and a slight rugosity representing the third.

Fig. 9. *Oxyæna lupina.* Right manus, natural size.

The lower jaw presents a broad thin angle, and a sharp narrow coronoid process. The roller of the condyle tapers sharply, as in *Felis*.

Oxyæna forcipata *Cope.*

We have referred to this species portions of two skeletons (Nos. 108, 109), distinguished by the heavy character of the bones. They include a tarsus, which agrees closely with that referred to this species by Cope, with the exception noted above. The former has two lower teeth associated with it, but they are so broken that the reference is uncertain. A jaw (No. 106), containing fragmentary molars, may also be placed here.

The *tarsus* (No. 109) is extremely interesting, as it appears to prove that Cope is mistaken in his description of the hind foot of *Oxyæna*. The calcaneum is complete and presents an oval ectal facet and a subcircular sustentacular facet. The astragalus lacks the outer portion of the tibial trochlea ; Cope's figure indicates that the tibial facet is very limited in the fore and aft direction, and that therefore *Oxyæna* was a plantigrade ; unfortunately this pes does not throw any light upon this point. A very striking feature of the foot is the broad contact between the cuboid and astragalus ; the cuboid is, as represented by Cope, directed outwards, but the *ectocuneiform is in close contact with it, proving that* *there could not have been a cleft* between the third and fourth toes. The entocuneiform is a high narrow bone; the mesocuneiform was evidently shorter.

The femur (No. 108) is remarkable for its heavy distal extremity, and its clumsy tibial and patellar facets. The tibia is correspondingly massive. The dorsals and lumbars are partly preserved. The latter have a short, rather obtuse, transverse process, and elevated zygapophyses interlocking by strongly concavo-convex facets.

Family PROVIVERIIDÆ.

Genus **Stypolophus** *Cope.*

This genus is represented by eight specimens (Nos. 94–101), some of which are in good preservation. There are three specimens (Nos. 96, 97, 98) belonging to *S. whitiæ* Cope; two are referred to the smaller form *S. viverrinus* Cope (Nos. 94, 95); and one well-preserved specimen is much larger than any form of *Stypolophus* hitherto described (No. 99).

Family MIACIDÆ.

Genus **Miacis** *Cope.*

Dentition I $_{3}$, C $_{1}$, P $_{4}$, M $_{3}$. First true molar tuberculo-sectorial; second and third molars tubercular.

Miacis canavus *Cope.*

A lower jaw (No. 83), which represents this species, has the symphyseal region well preserved, and enables us to determine the *alveoli of three incisors*, the number of these teeth having been hitherto unknown. The symphysis is narrow, and the alveoli are very crowded, indicating that the incisors were rather small. As described by Cope, the canine is large and compressed; the first premolar is single rooted; the second has two small roots; the third is larger; the fourth consists of a trenchant protocone, with faint anterior and a well-defined posterior basal cusp. The first molar is tuberculo-sectorial, with a rounded talon; the second is tubercular; the third is missing, and is represented only by the small alveolus.

There is a single second or third upper molar of the right side belonging to another individual (No. 85), which we provisionally refer to *Miacis*. It is distinguished from the corresponding teeth in *Stypolophus* by the broad external extension of the cingulum which supports no less than four low conical cusps outside of the typical pair of external cusps—the paracone and metacone. The intermediate tubercles are fairly well developed; the protocone is prominent.

Several other specimens can only be provisionally determined. A fragment (No. 84), containing the two lower tuberculars, we refer to *M. brevirostris*, as it is found in the Wind River. A second specimen (No. 87) contains a first lower tubercular of an individual much smaller than *M. canavus*, and there is a still smaller specimen (No. 86), which agrees in size with *M. edax* Cope, from the Bridger.

Genus **Didymictis** *Cope*.

This genus is characterized by two lower molars, one of which is of a tuberculo-sectorial type, while the other is tubercular and usually is a long somewhat narrow tooth. A well-preserved anterior triangle (trigonid) characterizes the Wahsatch species. The following determinations are not critical; they are based wholly upon Cope's diagnoses.

The two smallest jaws in the collection may be referred to the smallest form, *D. dawkinsianus* Cope (Nos. 89, 90). Together they contain the third and fourth premolars, and first and second molars. They are even smaller than Cope's types.

A much larger individual (No. 92) agrees with the type of *D. curtidens* Cope; this contains the first and second molars. The second molar, which has not been previously described, is long and rather narrow, with the typical three tubercles upon the trigonid and an elevated talonid. A second specimen (No. 93), containing the fourth premolar and first molar, may be referred to the same species, although the individual is somewhat smaller.

D. leptomylus Cope is represented by the posterior portion of a right mandible, an upper molar and numerous fragments. The upper molar resembles those of *Stypolophus whitiæ;* it has a single prominent tubercle upon the external cingulum.

Family MESONYCHIDÆ *Cope.*

This family, which is so well known through the writings of Cope and Scott, extended from the Puerco into the Bridger period. It is represented in the present collection by two species of *Pachyæna*, one of them new, and by a small jaw which we provisionally refer to *Dissacus*, a genus hitherto found only in the Puerco.

Dissacus leptognathus, sp. nov.

The species is distinguished from the Puerco forms (*D. navojovius* and *D. carnifex* Cope) by the extreme reduction of the postero-internal cusp (metaconid) of the trigon, which is partly separated from the protoconid.

The type is a portion of a small right mandible (No. 78), containing the second true molar complete and the broken crowns of the first molar and fourth premolar. It is reproduced, natural size, in the accompanying figure, and is about half as large as the types of the Puerco species. The characters of the molar cusps are evidently transitional between those of *Dissacus* and *Pachyæna*, so that the species might be referred to the latter genus.

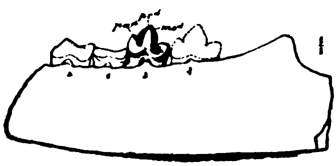

Fig. 10. ? *Dissacus* (*Pachyæna*) *leptognathus*, type. Inner aspect of right mandibular ramus.

The fourth premolar has a single main cone, the protoconid, and a sharp thin basal cusp or talon. The second molar has a small paraconid in the same line with the protoconid; the latter has a faint trace of the metaconid upon its inner slope; the hypoconid is proportioned as in *Pachyæna.*

Pachyæna ossifraga *Cope.*

The Wahsatch *Pachyæna* is distinguished from *Mesonyx* of the Bridger by the possession of three true molars in both jaws. The formula is I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{3}{3}$. The last upper premolar is molariform.

The only Wahsatch species hitherto known is the *P.* (*Mesonyx*) *ossifraga* Cope. We find three specimens in the collection which we can refer to this species. They consist of scattered lower teeth (No. 74); a fairly perfect left mandibular ramus, containing the third and fourth premolars and first molar (No. 75); and a single lower molar (No. 76).

Pachyæna gigantea, sp. nov.

This species is founded upon a series of finely-preserved upper cheek teeth lacking only the first premolar. The specific distinctions from *P. ossifraga* are very marked :—(*a*) the presence of a metacone upon the third upper molar; (*b*) the more complex structure of the third and fourth premolars; (*c*) the very broad crenate external cingulum; (*d*) the relatively smaller size of the metacone in the molars.

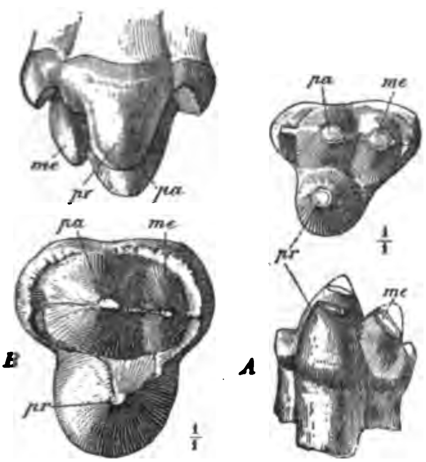

Fig. 11. *A*, *Pachyæna gigantea*, first superior molar of type, internal and crown views. *B*, *Pachyæna ossifraga*, type, fourth premolar or true molar, same views (National Museum). Both figures natural size.

The name is given in reference to the very large size of the animal. Prof. Cope estimates that *P. ossifraga* was as large as the largest Grizzly Bear (*Ursus horribilis*). Prof. Scott[1] has shown, however, that the Mesonychidæ were characterized by very large heads, and small, rather feeble bodies. Even with this reservation, while *M. lanius*, as restored by Scott, was 4½ feet long, *P. ossifraga* must have been over five feet, and *P. gigantea* was over seven feet or more than two metres in length. This is by far the largest of the Creodonta excepting the *Mesonyx uintensis* of the upper Eocene.

The main features of the teeth are (1) the very prominent cingulum; (2) the small size of the second external cusp (metacone);

[1] Journ. Acad. Nat. Sci. Phila., Vol. IX, 2d Ser., Pl. VI, 1886.

(3) the prominent ridge upon the postero-external slope of the protocone.

The second premolar is fractured upon the inner side, leaving us in doubt as to whether there was an internal cusp. The protocone is a high and compressed cone with a slightly ovate pos-

Fig. 12. *Pachyæna gigantea.* Crown view of superior molars of right side. Two-thirds natural size.

terior edge. In the third premolar the postero-internal cingulum rises into the basal talon (deuterocone); also into the internal basal shelf (trittocone), proving that both these cusps arise as *cingules* in the premolar series. The corresponding tooth in *P. ossifraga* has no internal lobe, as figured by Cope. The next tooth is completely molariform; it is much larger than the preceding, and much more worn than the first molar, suggesting the possibility that it may be a milk tooth, or that in this species the fourth premolar may receive an unusual amount of wear. Since all the teeth are isolated the position of the premolars is somewhat uncertain.

The first true molar presents a complete external cingulum rising at either end of the external lobe into high cingules; the metacone is much smaller than either the protocone or paracone. The second and third true molars exhibit a slight reduction in size; the external cingulum is less complete, and the metacone is gradually reduced.

Another specimen (No. 73), belonging to the same species, confirms the characters here assigned as distinguishing *P. gigantea* from *P. ossifraga*. In the true molars which are all well preserved, the metacone is even more reduced than in the type.

In premolar development *P. gigantea* is more progressive, but in the typical structure of the third molar it is more primitive than *P. ossifraga*.

The homologies of the lower molar cusps of these genera are rendered fairly certain by their derivation from those of *Dissacus;* the anterior cusp is the paraconid, the middle cusp is the protoconid, the posterior cusp is the hypoconid, the metaconid has entirely disappeared. The homologies of the upper cusps are somewhat uncertain; they appear to represent the typical trigonodont pattern with the protocone as the internal apex, and the paracone and metacone as the external base.

Family ARCTOCYONIDÆ *Cope.*

In this family we include the Creodonts with low crowned tubercular molars, as distinguished from those with one or more sectorial teeth. It contains *Arctocyon,* hitherto found only in France. We may, with Schlosser, provisionally add some of the forms described by Cope under *Mioclænus* of the American Puerco, and increase the list by *Anacodon* of the Wahsatch.

Anacodon was founded by Cope[1] in 1881 upon a portion of a lower jaw and some fragmentary lower molars. It has since remained one of the enigmas of the Wahsatch fauna. He placed it provisionally in the Phenacodontidæ.[2] The more complete material at our disposal still leaves its position somewhat uncertain, since we have no remains of the skeleton, but renders it very probable that it is a Creodont of a highly specialized type.

Anacodon ursidens *Cope.*

Dentition I $\frac{?}{1}$, C $\frac{?}{1}$, P $\frac{?}{3}$, M $\frac{3}{3}$. Upper molars tritubercular with a small hypocone. Lower molars quadritubercular. Premolars small, reduced in size and number. Coronal pattern obscured by crenulation of enamel.

There are three specimens in the collection, all of which were found in the uppermost Wahsatch strata. The first (No. 80) is a fragment of a lower jaw with the first and second molars in situ. The second (No. 81) consists of portions of two jaws with three molars, two premolars, and three upper molars. The third (No. 82) includes a palate with the upper molars and one premolar

[1] Proc. Am. Phil. Soc., 1881, p. 181.
[2] Tertiary Vertebrata, p. 427.

(Fig. 13) and the first and second lower molars. The latter corresponds in size with the type of *A. ursidens* Cope. The former two are smaller, but cannot be distinguished specifically. Both upper and lower series present a large second true molar, in front of which the teeth diminish rapidly in size, the fourth premolar is decidedly smaller and simpler than the first molar. The third premolar in the lower jaw is a diminutive tooth ; this is preceded by a diastema indicating that the first and second premolars were still more reduced or possibly wanting. The first characteristic of the genus therefore is the striking reduction of the premolars which sharply distinguishes it from any of the Ungulates, as well as from any known Creodonts.

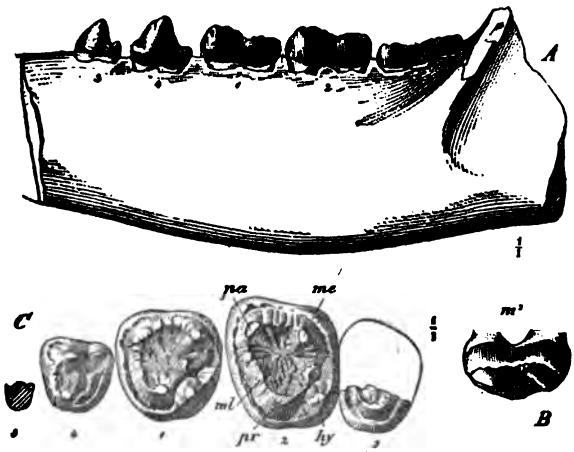

Fig. 13. *Anacodon ursidens.* *A*, Internal view of lower jaw. *B*, Crown view of upper molars. *C*, External view of second upper molar. Natural size.

The second characteristic is the excessive number of minute tubercles which cover the crown, and the extremely depressed summits of the cusps.

The upper true molars (Fig. 13, *B*, *C*), are completely surrounded by a cingulum, and upon the roughened unworn surface of the second we can just distinguish faint traces of the intermediate conules, *pl* and *ml*. Even the protocone is depressed ; the talon is well developed in *m2*, giving the crown a subquadrate outline, but *m1* and *m3* are more triangular. There is in fact no evidence of a hypocone upon *m3*, and it is feebly developed upon *m1*. The external cusps, *pa* and *me*, constitute the most elevated portions of the trigon. Only one upper premolar is preserved; this shows an elevated external cusp, and prominent internal cusp; in front of this is the alveolus of a small bifanged third premolar.

The lower molars (Fig. 13, *A*), consist of four cusps only—the protoconid, metaconid, hypoconid and entoconid. There is no trace of the paraconid or fifth cusp; and the hypoconulid, which is so prominent in *Phenacodus* and the Wahsatch Ungulates generally, is very faintly indicated in *m1* and *m2* by a slight elevation between the posterior pair of cusps. The third lower molar, however, has a well-developed third lobe, which invariably arises in the mammalia by a backward extension of the hypoconulid. Unlike the upper molars there is no trace of a cingulum. The fourth lower premolar is just emerging from the jaw (No. 81). It is only two-thirds the length and width of the first molar, thus presenting an extremely unique disproportion; it consists of a symmetrical protocone, with a concave posterior face and very slight indication of a talon. The third premolar is a diminutive tooth of the same form. In front of this is a diastema.

The characters and dimensions of the jaw are shown in the accompanying figure. The jaw was stout with a deep masseteric fossa. As regards the general structure of the dentition we must emphasize the following peculiarities:

1. The enlargement of the second molar in both jaws, the smaller size of the first and third, and the very marked reduction of the entire premolar series. There is no evidence that there were more than two premolars, and these were very small.

2. The degenerate condition of the cusps of the molars, and the formation of innumerable secondary tubercles or crenations.

3. The probable presence of a wide diastema.

Altogether *Anacodon* was a degenerate and highly specialized animal.

As regards its affinities they are certainly nearer *Arctocyon* than any other known fossil form, in fact there are many striking resemblances between these Wahsatch and Suessonian (Cernaysian) genera.[1] The older species of *Arctocyon*, the *A. primævus* of de la Fère, have four complete premolars and are much larger, but the type of the more recent species *A. gervaisii* (type of *Hyodectes* Cope) has but three premolars, and is of exactly the same size as our smaller specimens of *Anacodon*; in this species the anterior premolars *pm2* and *pm3* are being rapidly reduced (Lemoine, op. cit., Plate II), although the fourth is still of large size. Further similarities are sėen in the absence of the paraconid in the lower molars, in the broad cingulum of the upper molars, but mainly in the proportions of the upper molars (Osborn, op. cit., fig. 4), and relative development of the hypocone. Lemoine has figured accessory tubercles upon the lower molars of *A. gervaisii*.

The main difference between *Anacodon* and *Arctocyon* is the greater reduction in the premolars of the former. In the successive species of *Arctocyon* we however observe marked incipient tendencies to premolar reduction, which may have been carried further in *Anacodon*.

If these views are supported by additional evidence, we shall regard the bunodont Creodonta as first seen in *Mioclænus* of the Puerco, again represented in *Arctocyon* belonging to a period overlapping the Puerco and Wahsatch, and culminating in the summit of the Wahsatch in *Anacodon*.

Order AMBLYPODA *Cope.*

Suborder PANTODONTA[2] *Cope.*

Family CORYPHODONTIDÆ *Cope.*

Genus **Coryphodon** *Owen.*

The collection is very rich in remains of *Coryphodon*, the typical genus of the Wahsatch beds, including one specimen represented by the fore and hind limbs, feet and pelvis; the cervical vertebræ

[1] See Lemoine, Etude du Genre Arctocyon. Ann. d. Sciences Naturelles, July, 1878, Vol. VIII, No. 1. Also Osborn, A Review of the Cernaysian Mammalia. Proc. Acad. Nat. Sci., Phila., 1890, p. 51.

[2] This is equivalent to the Coryphodontia of Marsh.

and upper molars of another individual; a complete series of upper teeth of the largest type; upper and lower jaws of another specimen; the lower jaws of a young individual containing the milk dentition; and a large number of isolated teeth, limb-bones, foot-bones and vertebræ.

All the specific determinations proposed by Cope have, with the exception of the types of *C. pachypus* and of *C. anax*, been based upon the teeth, and the present collection has materially aided in clearing up the great confusion in nomenclature. Mr. Charles Earle, Assistant in Palæontology, has undertaken a complete revision of the nomenclature of the American Coryphodontidæ which will soon be published in this Bulletin. We are indebted to him for all the determinations and references here made.

Coryphodon radians *Cope.*—This species is represented by a complete series of maxillary teeth, and the cervical vertebræ of one individual (No. 274). There is also a complete series of inferior molars, premolars and canines (No. 259). Also a number of superior molars (No. 267). The above are from the Wahsatch.

From the Wind River beds we also find two last lower molars which cannot be distinguished from those of *C. radians*, together with many portions of the skeleton.

Coryphodon elephantopus *Cope.*—This species is represented by remains of one individual (No. 275), including the occipital and palatine region of a skull containing the true molars and premolars, excepting *pm 1*. This is very similar to the type of *C. hamatus* Marsh. Another individual (No. 260) contains portions of the third upper molar, of the lower canines and incisors. This species is very similar to the foregoing.

Coryphodon obliquus *Cope.*—This is represented by a nearly complete lower jaw (No. 276) lacking the incisors, and the upper molars and premolars. The value of this specimen lies in the somewhat unusual association of upper and lower teeth.

Coryphodon anax *Cope.*—As indicated by the name this is the largest species, and it probably includes *C. pachypus* Cope. The principal specimen is a skeleton without teeth including the humerus, radius and complete manus, the left innominate bone, the femur, tibia and fibula and complete pes; of the axial skeleton is included the atlas, axis and several scattered vertebral centra; also a series of peculiarly coalesced post-sacral or caudal vertebræ.

It is possible that the condition of the caudals found in this specimen was pathological, but they bear a perfectly normal appearance, and point to a unique caudal appendage. Behind the sacrum (which is wanting) we find remains of sub-cylindrical caudal centra, followed by a series of flattened centra which rapidly diminish in size posteriorly; these flattened centra become united together by the adjoining faces, and send out wide flattened transverse processes; but the most peculiar feature is the coalescence of the neural spines and laminæ into a long solid ridge which tapers off posteriorly and anteriorly, and renders this portion of the tail absolutely rigid. The only interpretation of this structure seems to be that the proximal portion of the tail was flexible, while the distal half formed a broad solid plate. The humerous suggestion has been made that this appendage supplied *Coryphodon* with a steering apparatus while swimming in the Big Horn Lake; it is impossible to make any serious conjecture as to the purpose which such a tail subserved.

The Foot Structure of Coryphodon.

The fore and hind feet of *Coryphodon* have been figured and described by both Marsh and Cope, yet neither of these authors has given an accurate idea of their real structure. Marsh[1] has figured both the manus and pes in the digitigrade position like the feet of the Elephant. In Cope's latest paper upon the Amblypoda[2] he says of *Coryphodon* and other members of the order, "The feet are always short and *plantigrade.*" Elsewhere,[3] however, he speaks of the movements of the Coryphodons as resembling those of the Elephant (*i. e.*, digitigrade); Cope's figures correspond with those here published, but fail to represent the actual position of the feet.

[1] Dinocerata, p. 184, figs. 150, 151.
[2] American Naturalist, Nov., 1884, p. 1110.
[3] Tertiary Vertebrata, p. 524.

The fact is that the positions of the fore and hind feet of *Coryphodon* were absolutely different, the *fore foot was digitigrade* like that of the Elephant, the *hind foot was plantigrade* like that of the Bear. In other words the carpus was entirely raised from the ground, and the manus rested upon the distal ends of the metacarpals and upon the spreading phalanges, while the calcaneum and tarsus rested directly upon the ground together with the entire plantar surface of the foot. This substantial difference between the advanced state of evolution of the fore foot, and retarded evolution of the hind foot, is of great interest; it is clearly shown in the accompanying figures.

Fig. 14. *Coryphodon*. Right fore foot, external view, exhibiting Cuneiform, *cn*., resting upon fifth metacarpal, *V*. (National Museum). One-third natural size.

We may therefore restate the characters of the feet of the Coryphodon as follows:

Manus.	*Pes.*
Digitigrade. Digits, five.	Plantigrade. Digits, five.
Scaphoid small.	Fibula rests upon astragalus and calcaneum.
Lunar enlarged, displaced upon unciform.	Astragalus displaced upon cuboid.
Trapezoid small.	A tibiale facet upon astragalus.
Second metacarpal with a large magnum facet.	Mesocuneiform short.
Third metacarpal with a large unciform facet.	Second metacarpal with a vertical ectocuneiform facet.

Variations.

Cuneiform articulates with fifth metacarpal (see Fig. 14.)	Fibula not articulating with calcaneum.
	Tibiale facet upon astragalus reduced.
	An 'astragalar foramen' (for flexor communis tendon).

The absence of the fibular facet upon the calcaneum has been observed in a specimen in the Smithsonian collection; also the cuneiform resting upon the fifth metacarpal. These differences, as well as the variations in the tibiale facet, require fuller investigation.

It will be noted that the manus has many points of functional parallelism with that of the Elephant, especially the enlargement of the lunar. The pes, on the other hand, is much more primitive than that of the Elephant.

Fig. 15. *Coryphodon anax.* Left hind foot, external view of the foot in the natural position. One-fourth natural size.

The figure of the pes of *Coryphodon* given by Marsh is somewhat similar to that of *Uintatherium* (*Dinoceras*), and is wholly different from those belonging to *Coryphodon* in the collections we have examined, since the astragalus is represented as *covering the entire upper surface of the cuboid*, and, as above noted, the foot is represented as digitigrade instead of plantigrade; the figure of the manus agrees with those we have examined, except that it is of a higher, narrower type. This author rarely errs in his figures, but in this case it would appear either that the astragalus is wrongly figured, or that these feet belong to some of the Dinocerata.

The Homologies of the Molar Cusps in Coryphodon.

While leaving to Mr. Earle the full discussion of the evolution of the molars of the Coryphodons, as indicated by the numerous variations in the molar pattern, the homologies of the molar elements with those of *Pantolambda* and of the Perissodactyla may be briefly pointed out. Cope is correct in the interpretation of the lower molar elements, but his interpretation of the upper molar homologies is much more uncertain. We have three means of determining the latter.

1. The comparison with the molars of *Pantolambda*.
2. The actual typical structure of the molars.
3. The vestiges of ancestral structure seen in specific variations.

The molar teeth of *Pantolambda* are tritubercular. There are two external subequal selenoid cusps, the paracone and metacone, separated by a slender median buttress, or mesostyle, with a strong anterior buttress, or parastyle; there are two faintly-marked intermediate tubercles, protoconule and metaconule, and a strong selenoid protocone; there are also anterior and posterior cingula.

The question is how has this selenodont molar been transformed into the lopho-selenodont molar of *Coryphodon?* Cope considers that the anterior crest, or protoloph, of the *Coryphodon* molar represents the union of the protocone and parastyle; that the median external cusp is the greatly reduced paracone, while the postero-external crescent certainly is the paracone. This theory is rendered clear by a study of the *Anchitherium* molar, and it is supported by this comparison, because it is shown in the Equidæ that *where there are two external crescents the protoloph is formed by the union of the protocone with the protoconule and parastyle.*

Another interpretation is the following: that the protoloph of *Coryphodon* represents the union of the protocone with the paracone; that the median external buttress represents the mesostyle; this is supported by the fact that the antero-external cusp in *Coryphodon* is often sub-crescentic as in *C. radians.*

Upon the whole, however, the evidence seems to favor Cope's theory. It is interesting to observe that in examining a large number of *Coryphodon* molars we find traces of the protoconule and metaconule; also faint traces of the mesostyle.

The anterior crest in the Coryphodons is therefore probably homologous with the anterior crest in the Perissodactyla, especially in the form exhibited in the Equidæ; the posterior crest (or metaloph) of the Perissodactyla is wholly wanting in *Coryphodon;* the external crest (ectoloph) of the Coryphodontia is homologous with the ectoloph or the posterior crest in the Dinocerata.

Order PERISSODACTYLA.

Family TAPIRIDÆ.

Subfamily SYSTEMODONTINÆ.

Genus **Systemodon** *Cope.*

Dentition: $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{4}$, $\frac{3}{3}$. Superior dental series continuous. First lower premolar contiguous to canine, followed by narrow diastema. Third and fourth superior premolars with two external cusps and a single internal lobe. Paracone and metacone subequal, conic. Protoloph and metaloph complete. Large third lobe upon third lower molar.

This Eocene Tapir ranks next to *Hyracotherium* in abundance during the Wahsatch period. In this collection there are nearly fifty specimens which may be referred to it, including numerous lower jaws and several fragmentary skulls. The only skeleton preserved embraces portions of a hind foot which unfortunately is of somewhat doubtful reference, as the associated teeth are only partially preserved. As Cope has shown, there are strong grounds for considering *Systemodon* an ancestor of the Tapirs, and certainly the Tapir stamp in the molar teeth is most striking, as shown in the accompanying figures (Figs. 16, 17) yet our opinion must be reserved until we learn the foot structure with certainty.

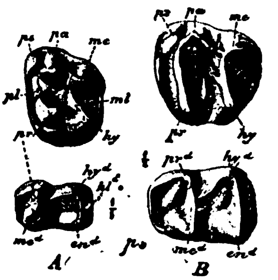

Fig. 16. *Systemodon* and *Tapirus*, first Superior and Inferior Molars. *A*, *Systemodon semihians*, showing Primary Cusps and Parastyle. *B*, *Tapirus indicus*, showing complete crests.

There are two species, *S. tapirinus* Cope, and *S. semihians* Cope. Our material enables us to distinguish them somewhat more clearly than Cope has done as follows:

S. tapirinus.	*S. semihians.*
Superior.—Internal lobe of second premolar large (Cope).	Same lobe small (Cope).
Intermediate tubercles merged into crests.	Same more distinct; crests interrupted.
External cingulum reduced.	External cingulum complete.
Inferior.—Posterior intermediate cusp (hypoconulid) rudimentary.	Same cusp, distinct.
Metaconid single.	Metaconid reduplicate (with metastylid).

The above tables make it evident that *S. semihians* is the more primitive form. In fact it is the most perfect example we know of, of the transition from the primitive bunodont into the pure lophodont type.

Systemodon tapirinus *Cope.*

This species includes the larger forms, and is much the most abundant.

A crushed skull (No. 149) shows that there was a delicate but prominent sagittal crest. The orbits were not enclosed, but protected posteriorly by a postorbital knob. The premaxillæ extended well upwards upon the side of the face. The nasals were slender, pointed and continued well forward, so that the nostrils were terminal. The lower jaw (No. 234) had a wide angle, and a small slender coronoid process strongly recurved; the condyle is very elevated; it faces upwards and is very slightly convex.

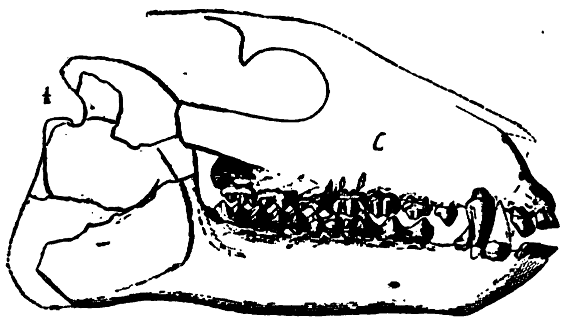

Fig. 17. *Systemodon tapirinus.* View of skull and lower jaw. Composition from two individuals.

The Dentition.—The most novel features of the collection are two specimens (Nos. 144, 150), containing the premaxillæ. The upper and lower incisors have obtusely pointed recurved crowns. The upper canines are large, vertically placed, and with sharply pointed tips; there are two types of lower canines, probably owing to sexual variation, one erect and prominent, the second slightly procumbent and shaped like the first premolar. Cope has noticed the absence of diastemata in the upper series; in the lower series we observe, as a very marked characteristic of the genus, that the first lower premolar adheres closely to the canine, and is followed by a diastema.

The importance of the *position of the first lower premolar* has not been sufficiently emphasized as *differentiating the different lines of Perissodactyla* we observe (*a*) that in the primitive Tapirine forms the first premolar is placed immediately behind the canine; (*b*) in the Equine forms, it is in the middle of the diastema between the canine and the second premolar; (*c*) in the rhinocerotine forms it is always placed behind the diastema close to the second premolar. By this simple law the early representatives of these three lines may be readily distinguished.

The Skeleton.—Many portions of a fragmentary skeleton are associated with a lower jaw and teeth (No. 234), including an astragalus, calcaneum, cuboid, two cuneiforms, several metapodials and proximal phalanges. The tarsus is of a more contracted type than we had anticipated would be found. The astragalus and calcaneum are strikingly like those of *Heptodon*; the cuboid is, however, much shorter, and the tarsus was therefore proportionally shorter and broader. As in *Heptodon* and *Hyracotherium* there is no lateral displacement, the astragalus having a very narrow contact with the cuboid. There were evidently but three digits with well-marked posterior keels. The phalanges are long and slender; unfortunately the distal ones are not preserved.

The head of the femur is perfectly round with a decided pit for the round ligament.

Systemodon semihians *Cope.*

This species includes the more primitive and somewhat smaller forms from the Wahsatch.

The specific characters of the teeth are both progressive and retrogressive. The retention of the posterior intermediate tubercle upon the lower molars is an inheritance from the Condylarthra in which this cusp is invariably present; the broad external cingulum, the low crests, and the still apparent intermediate tubercles of the upper molars are also primitive marks. The appearance of an accessory tubercle (metastylid) behind the metaconid is, on the other hand, a secondary character; it seems to be more distinctly developed in this species than in *S. tapirinus*.

2.—*The Wind River Fauna.*

The Wind River collection includes portions of the fore and hind limbs and the complete jaws of *Palæosyops borealis*, also the jaws and nearly complete fore and hind limbs of *Heptodon calciculus*.

Family HELALETIDÆ.

Small perissodactyl mammals extending from the lower Eocene to the lower Miocene. Molars lophodont; paracone and metacone of same size; metacone flattened and placed internally. Ectoloph incomplete, or notched, as in Tapir. Protoloph and metaloph complete. Feet tending to monodactylism, lateral digits shorter than median digit. Terminal phalanges compressed.

This family includes *Heptodon* of the Wahsatch and Wind River, *Helaletes* of the Bridger, and a White River (Miocene) genus which cannot be defined because the premolars are unknown.

Genus **Heptodon** *Cope.*

Dentition: I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{3}{3}$. Last inferior molar with a small heel. Third and fourth superior premolars with single transverse crests, well-developed external crests and anterior buttress. Digits 4–3.

Heptodon calciculus *Cope.*

Dentition.—Nine of the twelve upper and lower incisors are preserved and exhibit spatulate to chisel-shaped crowns. The canines are rather slender and finely pointed. The first upper premolar is bifanged and, as in all the rhinocerotiform group, is behind the diastema and close to the second premolar. The latter tooth has a single protocone and a broad internal shelf. The third and fourth premolars exhibit an anterior buttress (parastyle), and two conic external cusps; there is a well-defined anterior crest (protoloph), and an incipient posterior crest (metaloph). The true molars have the conic paracone and flattened metacone which Cope has pointed out as characteristic of this line, the latter has a postero-external cingulum; the crests are sharply defined.

In the lower jaws we find a corresponding diastema behind the canine and a small single-fanged first premolar. This differs from Cope's type (Tert. Vert., p. 656) in which the first premolar is wanting on one side. The second premolar has a narrow posterior talon. The third premolar is less advanced than the corresponding upper tooth, since the anterior and posterior crests are in the most incipient stage. The fourth premolar shows a well-marked metalophid, or anterior crest, and a crested talon. Each of the true molars exhibits a spur extending inwards from the protoconid which represents the primitive line of connection with the paraconid and with a similar fold from the hypoconid to the spurs from the anterior and posterior crests of the rhinocerotiform inferior molar. The third lower molar has a conic third lobe (hypoconulid), which it is very interesting to trace among Bridger successors of the genus.

Lower Jaws.—The lower jaws are beautifully preserved and are remarkable for the slender coronoid process, the elevated condyle, the widely rounded posterior border of the angle. The symphysis extends as far back as a line drawn vertically below the second premolar. The skull is wanting.

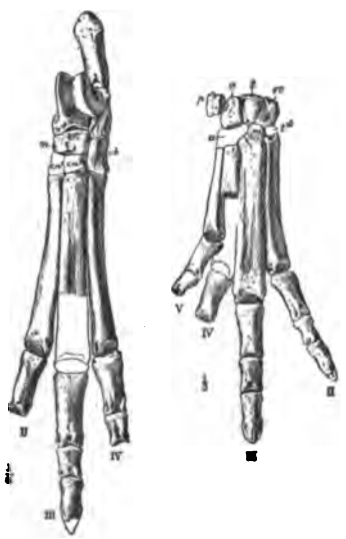

Fig. 18. *Heptodon calciculus.* Left hind foot. Right fore foot. One-third natural size.

Fore Limb.—The limbs as well as the dentition indicate that this individual was not fully mature. The humerus has elevated greater and lesser tuberosities, and a deep, single, bicipital groove; distally, there is a sigmoid radial trochlea, above which is an oval supratrochlear foramen; the internal condyle is slightly more prominent than the external. The ulna and radius are well preserved; they are elongate, slender and arched forwards.

The Manus.—Several of the carpals are preserved; the proportions of the wrist are similar to those in *Hyrachyus*, that is, high and rather narrow. The displacement is similarly advanced; the scaphoid rests widely upon the magnum; the lunar retains a narrow magnum facet and rests mainly upon the unciform; the magnum has an elevated posterior process articulating between the lunar and unciform. The metapodials are of unequal lengths and as a whole shorter than in the Bridger forms, the central metacarpal being 2⅝ inches in length, while the second and fourth are ⅜ of an inch shorter; there are sharp keels upon the posterior distal surfaces. The proximal phalanges are much the longest; the distal phalanges are long and much compressed with a deep distal median groove.

The pes is much longer and stouter than the manus, with a high narrow tarsus, three stout digits and elongate phalanges. The calcaneum is high and compressed, with a superior fibular facet; the ectal facet is separate, but the ental and sustentacular facets are continuous, as in some species of *Hyrachyus*, with an intermediate groove for a corresponding ridge upon the astragalus. The astragalus has a deep tibial trochlea, a narrow navicular facet, but, as in *Hyrachyus*, it only rests upon the cuboid posteriorly by a narrow facet as in the Equidæ, and not anteriorly as in the Tapirs and Rhinoceroses. The cuboid is elevated and compressed in the centre as in *Hyrachyus*. The navicular is deep, and has a small external contact with the calcaneum, as in the early Hyracotheriinæ. The external or fourth metatarsal is turned outwards, and has a rather slender oval shaft; the third metatarsal has a stout flattened shaft. The proximal phalanges are long and laterally compressed.

The femur has a small projecting head, an elevated incurved great trochanter, and prominent lesser and third trochanters, with a deep trochanteric fossa; the shaft is recurved, and has a deep antero-posterior section.

The tibia has a double spine, a very long and prominent cnemial crest, and a slight sigmoid or double curvature of the shaft.

Restoration.—The limbs and jaws of this young individual indicate that *Heptodon calciculus* was a slender digitigrade perissodactyl, about forty inches long and eighteen inches high (100 x 45 centimeters), with not far from the same dimensions, but of a much more slender type than the Collared Peccary (*Dicotyles tajacu*). The hind limb was much longer and more powerful in all its dimensions than the fore limb, and points to habits of rapid locomotion. In fact, although the tibia and femur are of equal length, the proportions of the limbs and the extreme lateral compression of the hoofs suggest a resemblance to the Cervidæ in locomotion rather than to any of the known Perissodactyla.

The feet are extremely interesting because of the elongation of the median digit, and the shortening of the lateral digits; this character is well shown in the manus, and was probably exhibited in the same degree in the pes, but unfortunately the median digit is incomplete distally in our specimen. In other words, *H. calciculus* exhibits a more marked degree of lateral reduction than the contemporary Wind River Horse, *Hyracotherium venticolum*, which was in a true monodactyl line; there is, however, no compensating enlargement of the magnum.

This specimen of *H. calciculus* was about half as large again as the Wind River *Hyracotherium* restored by Cope, and, compared with later Bridger forms, was one-third smaller than the *Triplopus cubitalis* of the upper Bridger. It is slightly larger than the *Palaplotherium minus* of the Débruge of France.

The Relationships of Heptodon and Helaletes.—Cope has placed *Heptodon* in the ancestral line of *Hyrachyus*. Osborn has considered it much nearer *Helaletes* Marsh of the Bridger. *Helaletes* was placed by Marsh in the ancestral line of the Tapirs, on account of the presence of a small heel upon the third lower molar, but Osborn[1] has shown that the teeth of *Helaletes* remove it entirely from any relationship to the Tapirs, and has pointed out the probable generic identity of *Desmatotherium* Scott and *Dilophodon* Scott with *Helaletes*.

The discovery of the skeleton of *Heptodon* confirms Osborn's view as to the close relation between *Heptodon* and *Helaletes*, and enables us to form some opinion as to the phylogenetic relationships of these forms. First a word as to nomenclature.

[1] The Mammalia of the Uinta Formation, p. 523.

The synonomy of *Helaletes* is rich, as species variously referred by Leidy, Marsh, Scott and Osborn to *Lophiodon*, *Hyrachyus*, *Desmatotherium* and *Dilophodon* all belong to this genus. It is distinguished from *Hyrachyus*, and marks an advance upon *Heptodon*, by the presence of two internal lobes upon the third and fourth upper premolars. It is further distinguished from *Hyrachyus* and related to *Heptodon* by the variable development of the third lobe upon the last lower molar. Marsh attached considerable importance to this character, in making it a basis of tapirine affinity, but in the six or seven specimens from the Bridger beds in the collections of the Philadelphia Academy and of Princeton, the third lobe (hypoconulid) presents every degree of degeneration from a small distinct cusp, as seen in *H. boops* Marsh, and its synonym *H.* (*Hyrachyus*) *nanus* Leidy, to a basal cingulum, as in *H.* (*Dilophodon*) *minusculus* Scott. In this genus, therefore, this lobe is merely of specific value, and is rapidly disappearing.

We can now define *Heptodon*, *Helaletes* and *Hyrachyus*, as follows :

Heptodon Cope.	*Helaletes* Marsh.	*Hyrachyus* Leidy.
Premolars $\frac{4}{4-3}$. Third and fourth upper premolars with a single crest and single internal lobe. Third lobe of the last lower molar constant. Paracone conic, and metacone flattened, symmetrical, of equal length.	Premolars $\frac{4}{3}$. Third and fourth upper premolars with two internal lobes. Third lobe of the last lower molar variable. Paracone conic, and metacone flattened, symmetrical, of equal length.	Premolars $\frac{4}{4}$. Third and fourth upper premolars with two transverse crests and single internal lobe. M3 without third lobe. Paracone conic, and metacone flattened, asymmetrical, metacone longer than paracone.

Heptodon calciculus agrees closely with *Helaletes boops* in the characters of the tarsus, except that in the latter the two lower facets of the astragalus are not continuous, as observed in Marsh's type individual.

It is clear that *Heptodon* and *Helaletes* represent a line of succession contemporary with that of *Hyrachyus-Triplopus-Hyracodon*, but distinct from it in many characters. The difference is shown in a comparison of the external cusps of the upper molars ; in all the three latter genera they are rhinocerotiform ; that is, the metacone is much longer than the paracone, and forms a continuous ectoloph. In the *Helaletidæ*, on the other hand, the external lobes are of equal size, although the paracone is convex, and the metacone concave, and the ectoloph is interrupted as in the Tapirs.

The nearest relatives of this line are therefore not the American *Hyrachyus* series, but the true *Lophiodon* series of Europe. It is possible that the Helaletidæ will prove to be a branch of the Lophiodontidæ.

Family TITANOTHERIIDÆ.

Subfamily PALÆOSYOPINÆ.

Genus **Palæosyops** *Leidy.*

It is extremely interesting to find a well-advanced species of this distinctively Middle and Upper Eocene animal in the same horizon (Wind River) with the last representatives of the Coryphodontidæ and Phenacodontidæ, so characteristic of the lower Eocene. *Palæosyops borealis* Cope was an animal only one-fifth smaller than the Brazilian Tapir, *T. americanus.* It was much larger than its contemporaries *Heptodon* and *Hyracotherium*, and equaled in size *Bathyopsis*, the representative of the Dinocerata in the same beds. It was therefore second in size only to *Coryphodon* among the Wind River fauna. This fauna is well known as a mixed fauna of Wahsatch and Bridger types.

Palæosyops borealis *Cope.*

Superior molars quadrate ; external crescents (paracone and metacone) broad and shallow ; mesostyle prominent ; protoloph faintly marked upon m1 and 2 ; intermediate tubercles (proto- and metaconules) reduced. Inferior third molars with a small conical third lobe (hypoconulid). First lower premolar spacing the diastema.

This species is represented by several portions of the skeleton of a single individual (No. 296), which fortunately supplement the knowledge obtained from Professor Cope's fragmentary type specimen. The specific identification is based upon the fact that the dental series coincides exactly with the upper molars and premolars of Cope's type ; the two lunar bones are also exactly similar. They include a complete lower jaw, two cervicals, three dorsals, and a caudal vertebra, a femur and a humerus, and the greater part of a fore foot.

The jaw is in fine preservation, lacking only the incisors, canines and first premolars. The canines were large and semiprocumbent; the first premolar was single rooted, and placed a short space behind the canines; the second premolar has a sharp laterally compressed crown consisting of an elevated protocone, and distinct but depressed talon; the third premolar is lower and broader, with a more depressed protocone and a V-shaped talon; the fourth premolar is submolariform, consisting of two Vs, the metalophid (anterior crest) is well developed with its spur, but the hypolophid (posterior crest) is still wanting. In the first true molars the anterior portion of the crown is higher than the posterior, but in the second molar these regions (trigon and talon) are subequal; the third molar has a small conical third lobe (hypoconulid); the molars increase in size from first to third.

The mandibular rami are characterized by broad, highly convex condyles, slender recurved coronoid processes, deep angles and inferior borders rising rapidly to the narrow, elongate and convex symphyseal region.

The sixth and seventh cervical vertebræ exhibit broad, slightly keeled centra, large arched neural canals, and flat, obliquely placed zygapophysial facets; the spines are broken, but were evidently quite high; the seventh cervical is imperforate. The dorsals belong to the anterior portion of the column; the centra are laterally compressed and trihedral in mid-section; the zygapophyses are small and nearly horizontal, the spines are slender and have a trihedral section, the metapophyses are elevated and slender; the parapophyses are not preserved.

The *femur* lacks the head. In comparison with the Bridger species it is distinguished by the great prominence of the third trochanter; the second trochanter was also prominent; the great trochanter was slightly below the level of the head; the shaft has a flattened posterior face as in all the known species of *Palæosyops*.

The *humerus* has a very deep antero-posterior section in the upper portion of the shaft; the tuberosities are partly broken; the bicipital groove is very broad; the deltoid ridge is more prominent than in the Bridger species; the supinator ridge is normal; there is a well-marked tuberous projection for the *latis-*

simus dorsi; the supratrochlear pit is imperforate; the condyles are subequal.

The Manus.—The structure of the right fore foot is extremely interesting, because of its *functional tridactylism;* (1) the upper half of the fifth metapodial is preserved; it is decidedly more slender than the second metapodial. Other proofs of functional tridactylism are: (2) the enlarged third metapodial (Mtc. III), which is much longer than the second and fourth; (3) the carpal displacement is extreme, the lunar rests wholly upon the unciform, and has a narrow vertical facet for the magnum; (4) the unciform and magnum are high and narrow. In short this foot is distinctively mesaxonic and functionally tridactyl, whereas the later forms from the Bridger are so far as known paraxonic and functionally tetradactyl; in other words we find an early species with a more progressive and modified type of foot than the later species, a state of affairs which is decidedly inconvenient for the evolutionist.

Affinities.—According to Earle, who has in press an exhaustive memoir upon the *Palæosyopinæ*, the affinities of the upper molars of *P. borealis* are with those of the Bridger species *P.* (*Telmatotherium*) *cultridens*, which he considers in the persistent line of succession leading to *Diplacodon* and *Titanotherium*. The incipient tridactyl foot structure of *P. borealis* has affinities with that of *P.* (*Limnohyops*) *laticeps* of the Bridger, but the latter is of a more pronounced tetradactyl type. Altogether the discovery of the feet leaves the phyletic position of *P. borealis* more uncertain than before.

V.—Geological and Geographical Sketch of the Wahsatch Exposures in the Big Horn Mountains.

The valley or basin of the Big Horn lies in almost the extreme northwestern portion of the State of Wyoming, slightly overlapping the line between this State and Montana on the north. Geographically considered it forms an isolated basin enclosed for the most part by high mountain barriers, which for the greater portion of the year are covered with snow. In consequence of this fact, together with the rugged character of the country, travel is at all times difficult, and it is only during the time that the snow is absent that it can be said to be entirely and easily accessible.

In order that the following brief description of its geology may be made more intelligible, I append a short sketch of the geography of the region.

The present geographical boundaries of the basin are very similar to if not identical with those which enclosed the ancient Big Horn Lake, and it is to be seriously doubted if any considerable local disturbances of level have occurred in this region since the beginning of the Wahsatch epoch. The boundary of the basin upon the west is furnished by the main chain of the Rocky Mountains, which here has a direction almost due north and south.

Upon the east, at a distance varying from fifty to seventy-five miles, lies the Big Horn Range almost parallel with the Rockies. Its northern boundary is indicated by the Pryor Mountains, a spur which puts out from the Big Horn to join the main Rocky range. The general trend of this divide is to the northwest, and it is not so well defined nor so high as either the eastern or western boundaries, especially in its northwestern portion.

Upon the south a well-marked but lower range connects the Rockies with the Big Horn Mountains, and although somewhat irregular in direction, has a general trend east and west. This range is cleft about midway by a deep cañon through which the Big Horn River flows and becomes continuous with the Big Horn Range.

To the east of this cañon the mountains are known as the Rattlesnake Range, while on the west they take the name of the Owl Creek Mountains. It is a matter of some interest to note, that while this Rattlesnake-Owl Creek range forms the southern boundary of the Big Horn basin, it also forms the northern boundary of the Wind River basin, which is also the site of an ancient lake which came into existence after the Big Horn Lake was drained.

The basin thus enclosed is about one hundred and fifty miles in length, by from fifty to seventy-five miles in width. It is irregularly oval in form, and has an elevation above sea level of about 3500 feet.

Its drainage is by a number of streams, the principal one of which is the Big Horn River. Above or to the south of the Owl Creek Cañon this stream is known as Big Wind River, but after it passes through the cañon it takes the name of the Big Horn. Its general direction from the Owl Creek cañon to the second gorge, which it has formed in its passage through the Pryor Mountains, is almost due north, and it may be said to lie well to the eastern side of the basin in its passage through it. It finally empties itself into the Yellowstone near Fort Custer, Montana.

Upon the west it receives a number of tributaries, two of which at least are sizable streams at all seasons of the year, and are derived from the melting snows of the high rugged Rockies. The first of these tributaries, beginning upon the north, is Owl Creek, a comparatively small stream, some thirty or forty miles in length, which drains the northern slope of the Owl Creek range, but which goes dry in the latter part of the summer or early fall. Then follow a number of creeks of similar nature whose courses do not extend to the snowy mountains, and which consequently go dry in the summer. They are Cottonwood, Gooseberry, Fifteen-mile, Ten-mile, Five-mile and Elk Creeks, in the order named.

The next tributary is the Gray Bull, a beautiful stream fed by the melting snows from the high mountains to the west. In the spring and early summer it is high, rapid and dangerous, so much so as to interfere materially with our operations in its vicinity during our explorations there. It is said to have a mean fall of seventy-five feet to the mile from the point where it enters the basin proper, and its waters are used for irrigating purposes by the ranchers who have settled in its fertile valley.

Stinking Water, also fed by the snows of the Rockies, is the next stream on the north, and is somewhat larger than the Gray Bull. It flows with a rapid descent through a cañon for the greater part of its course, and falls into the Big Horn a short distance to the south of the Pryor Gorge. Its name is derived from the distinctly sulphurous odor of the water caused by a number of sulphur springs along its course.

The two tributaries derived from the Big Horn range upon the east are comparatively small and unimportant streams except in spring when there is rapid melting of the snows, and then they are high and turbulent. No Wood, the larger of the two, reaches the Big Horn some fifteen or twenty miles above the mouth of the Gray Bull, while Shell Creek, the other principal tributary from this direction, empties itself into the Big Horn a short distance above Pryon Cañon or the northern gorge of the main river. As is the case upon the west side, there are in addition a number of small streams which are dry for the greater part of the year. The principal one of these is Kirby Creek, which receives the water shed of the northern slopes of the Rattlesnake range, and is the corresponding stream to Owl Creek upon the west.

Another stream which is not a tributary of the Big Horn, but which, properly speaking, belongs to the drainage system of the Big Horn basin, is Clarke's Fork. This stream is about equal in size to Stinking Water, and takes its rise in the high snowy mountains of the main Rocky range to the north of this latter stream. It has formed for itself an independent outlet to the northeast through the low divide which connects the Pryor Mountains with the Rockies, and after gathering a number of tributaries runs parallel with the Big Horn and finally falls into the Yellowstone near the small town of Billings. Its basin, although geographically separate from that of the Big Horn, is geologically a part of it, as I was able to determine after careful examination of its structure.

The general character of the country enclosed within the basin just described may be said, for the most part, to be that of a barren, sage brush, bad-land desert, very uneven and badly broken by the irregular weathering of the soft Wahsatch sediment with which it was at one time completely filled. The appearance presented by this sediment at the present time is characteristically that of the bad-land scenery so common in the Rocky Mountain region.

The Big Horn Basin.

Geology.—The geological history of the Big Horn basin is not difficult to decipher, owing to the lack of vegetable growth and the consequent exposure of all the formations entering into its structure. It may be briefly told as follows: Sometime between the close of the Cretaceous epoch and the beginning of the Wahsatch division of the Eocene, the flexure or fold which gave rise to the main Rocky Mountain chain had been elevated, and with it came the subsidiary uplifts which formed the Big Horn range, together with the connecting spurs, the Pryor and Owl Creek mountains. The result of these changes was the formation of an extensive basin walled in by the high mountain barriers already described. There is every reason to believe that the elevation of these mountain ranges was very much more considerable than it is at the present time, since the softer sedimentary rocks have for the most part been removed from their summits, which now exhibit the granitic nucleus of which they are largely composed.

The elevation of these folds took place from the sea-bottom, carrying upwards the older formations which at first formed continuous layers over these mountain ridges, but as the work of erosion and denudation progressed they were removed from the crests of the ranges, and are consequently now represented along the bases of the mountains by sections of their original thickness, tilted up at a considerable angle following the original curve of the fold.

Upon completion of the uplifts the basin became filled with fresh water, and then began the accumulation of that vast layer of sediment which marks the Wahsatch division of the Eocene period.

Gradually the basin was filled with the débris washed down from the neighboring mountain sides, in all probability largely derived from the older sediments which were now above water, until finally, after the lapse of a long period of years, measured by the accumulation of a mass not less than 2500 feet in thickness, the waters of the lake found an outlet through one or more of the low mountain passes, and at once began the work of wearing down a channel through them. As this channel was worn deeper and deeper it finally reached a point where the waters of the lake were drained off, and the rivers instead of longer depositing their load of sediment in the still waters of the lake, carried them on seaward. With the drainage of the waters of the lake began the process of scoring out the present valleys of the basin, and the carving out of the lake sediment into the remarkable bad-land stretches that are to be seen to-day.

Although I had no means of accurate measurement I was able to determine the approximate thickness of the Wahsatch deposits by the height of surrounding peaks, together with evidence gathered by the county surveys of certain parts of the basin. Just below the bridge at the crossing of the stage road on the south side of Stinking Water stands a bad-land peak (McCulloch's Peak) which is variously stated to be 1500 and 1800 feet high. It is composed entirely of Wahsatch sediment from base to summit, as was determined by the fossils in its vicinity. From this peak to the mouth of Stinking Water is a distance of 25 or 30 miles, and it is said to have a fall of 40 or 50 feet to the mile. It passes through Wahsatch beds all the way, and considering the fact that these beds are horizontal, another 1000 feet must be added to give the entire thickness of the deposit. This does not take into account the wearing away or erosion that has taken place from the summit of the peak, which, during the long period it has been exposed, must have been considerable. At all events, in the absence of exact measurements, I think it entirely within the bounds of probability to say that the thickness of the sediments of the Big Horn Lake, as they are now exposed, is not less than 2500 feet. King[1] gives the aggregate thickness of the Vermillion Creek beds, which contain practically the same fauna as the Big Horn deposits, and are without doubt of the same age, as 5000 feet. In a former

[1] United States Geological Explorations of the Fortieth Parallel, Vol. I, Systematic Geology, p. 360.

paper which I published upon the subject,[1] the thicknesses of the Big Horn sediments are given as 4000 feet. This is probably erroneous and was based upon inaccurate computations of the heights of some of the Bad Land Buttes.

Above the bridge at the crossing of Stinking Water the river has cut down to the underlying rocks, and an instructive section is exposed. Here the Wahsatch or Big Horn sediments are seen to lie unconformably upon the older beds. This is shown in many places throughout the basin, and is positive evidence of the fact that there was a distinct break in the deposit of sediment between the older and the newer series. In the Stinking Water section the older formations dip away to the eastward at an angle of 30° or 40°, while the Big Horn strata lie almost if not quite horizontal.

The question of the age of the older rocks is not easy of solution, and in the almost total absence of fossil remains any exact determination is well nigh impossible. As observed upon the northern slopes of the Owl Creek Mountains the succession is as follows: thick masses of limestone resting apparently directly upon the granite, and forming a large part of the crest of the range; this is followed by an intensely red sandstone layer of considerable thickness which Hayden frequently spoke of as the "Jura-Trias red beds." After this comes a succession of layers of bluish clay alternating with beds of compact brown and rusty colored sandstones. In places these sandstones are interbedded with thin strata of coal, some of which is of good quality. At Red Lodge, Montana, these coal veins are of sufficient thickness to admit of extensive mining operations, and it is from this locality that a large part of the coal supply of this region is furnished.

In the mines at Red Lodge some fossil shells have been found, and among them is to be distinguished a large species of the genus *Inoceramus*, which Prof. Whitfield informs me is characteristic of the Dakota division of the Cretaceous. In regard to the continuity of the coal-bearing sandstones and clays at the Red Lodge exposures, with similar exposures in the Big Horn region, I do not think there can be any question; in fact, the same exposures

[1] Proc. Amer. Phil. Soc. Phila., Dec. 1881, p. 139.

are met with on the Big Horn side of the divide but a few miles from Red Lodge on Bear Creek, a tributary of Clarke's Fork, and these beds again appear to be continuous with the coal veins found in so many parts of the basin.

Between these coal-bearing strata and the base of the Wahsatch sediments there intervenes a very thick layer of sandstone, which seems to present the same general lithological characters as the underlying sandstones. An exception to this, however, is found in a section exposed on Stinking Water, where the sandstone immediately underlying the Wahsatch contains faint traces of impure lignite. It may be that these beds are to be referred to the Laramie Cretaceous, but if this is true they are very different from the Laramie exposures to the east of the Big Horn Mountains, with which I am personally familiar. King observes,[1] "Between the uppermost members of the Laramie Cretaceous and the lower beds of the Vermillion Creek Eocene, there is but very slight lithological difference. They are both reddish, friable sandy rocks." This certainly does not agree with the description of the beds underlying the Big Horn sediments, and it is somewhat doubtful if the Laramie is here represented. I was unable to find any strata that would represent the Puerco deposits, and it is more than probable that this formation is also absent in this region.

The Wahsatch sediments are made up entirely of beds of clay and sandstone. The clays vary in color from a light buff to a brick red, although in some places they have a distinctively bluish or slate-colored tint. They contain much lime in the form of small rusty nodules in which the fossils are usually found, and not unfrequently there is much admixture of sand. In other places the sand and clay beds are sharply defined from each other, indicating in all probability rapid changes of the currents of the lake. They are for the most part in an extremely fine state of division, and were undoubtedly derived principally from the erosion of the older Cretaceous and Jurassic formations. The sandstone layers, upon the other hand, are composed of much coarser materials, and very rarely contain the lime nodules seen

[1] Loc. cit., p. 360.

in the clay. They vary in thickness from one to twenty feet, and in some instances even more. When first exposed they are somewhat bluish in color, but owing to the presence of iron they assume a decided rusty color after much weathering.

The fossils are found almost exclusively in the clays, although their occurrence in the sandstones is not unknown. In the clays they are in a majority of instances badly broken and crushed, caused no doubt by the settling and packing of this sediment. In the sandstone, upon the other hand, the bones are generally well preserved, and nearly all of the choice specimens have been derived from this material.

The principal fossil bearing exposures are found in the vicinity of the Gray Bull and Stinking Water, although Buffalo Basin, which is really the upper part of the basin of Fifteen Mile Creek, also contains some good exposures. The exposures without exception face to the northwest, a fact which is explained by the prevailing direction of the storms in the winter and spring.

The basin of Clarke's Fork, although generally regarded as having been filled with deposits of Cretaceous age, is identical in its structure with the Big Horn basin proper. The older formations are the same, and I was able to trace the continuity of the Wahsatch deposits across the high divide, or mesa, from Stinking Water. Not content with this evidence I made careful search for fossils in the exposures of the Clark's Fork basin, and was rewarded by the finding of enough material to settle the age of these beds without further question. The remains are all mammalian, and the species represented are characteristically those of the Wahsatch.

The Wind River Basin.

There yet remains to discuss the relationship between the Big Horn and Wind River Lakes. As already indicated, the Wind River basin lies to the south of the Big Horn basin, and is now drained by the same river system, viz.: by the Big Horn and its continuation, the Big Wind River. The Wind River or upper basin was filled with sediment in the same manner as that of the Big Horn, but it is of a later age as is abundantly demonstrated by the fauna it contains.

Now the Owl Creek-Rattlesnake range, as already remarked, formed the southern boundary of the Big Horn Lake and the northern boundary of the Wind River Lake, and the question naturally arises, how can it be that the upper basin is later in age? One would naturally suppose that the upheaval of the Owl Creek Mountains, which formed the southern boundary of the Big Horn Lake, would have also cut off a basin to the south, and that the lower strata of the Wind River deposits would be of the same age as those of the Big Horn. Such, however, is not the case. Every part of the Wind River sediment, from base to summit, belongs to a later geological epoch.

The Wind River Lake was surrounded by high mountain ranges, and its deposits were of great thickness, equal perhaps to that of the Big Horn. How can this be explained?

In trying to make out this problem there was one fact that struck me as very significant, and that was that while all the older formations on the northern slopes of the Owl Creek and Rattlesnake Mountains were in a measure intact and comparatively weathered, on the southern or Wind River side the older rocks had been almost entirely swept away, leaving the granite exposed throughout almost the entire extent of the range. This was not done, moreover, since the close of the Wind River epoch, but prior to the laying down of the Wind River sediments, since they are seen in this immediate section to rest directly upon the granite without any trace whatever of the older rocks.

The presumption is therefore that the Wind River country was above water during the existence of the Big Horn Lake, and that the drainage was in another direction—probably to the east—before the present eastern barrier of the Wind River basin was elevated. This would account for the preservation of the older sediments on the Big Horn side of the Owl Creek Mountains, and their remarkable erosion upon the southern or Wind River side.

Sometime subsequent to the close of the Big Horn period a second elevation took place, which cut off the outlet of the waters of the Wind River region, and a second lake was formed on the site of the present Wind River basin. Just how much time elapsed between these changes is difficult to determine, but judging from the relations of their respective faunæ it could not have been very great.

When the Wind River Lake was finally filled its waters found an outlet to the north, excavating the remarkable gorge now known as the Wind River Cañon. It is through this channel that the drainage has since found an outlet seawards.

Summary.

The following are the main features of my observations:

1. That the Puerco and Laramie do not underlie the Wahsatch in the Big Horn basin, but the strata rest upon older secondary rocks.

2. That the thickness of the Wahsatch in this basin is about 2500 feet, or considerably less than the 4000 assigned to the same strata in the Vermillion Creek exposures.

3. That the Clarke's Fork basin, although geographically separate, is in age and deposition identical with the Big Horn basin.

4. That the Wind River beds are absolutely distinct from the Big Horn Wahsatch, and belong to a succeeding deposition.

VI.—Narrative of Expedition of 1891.

The expedition into the Big Horn region of Wyoming was outfitted at Red Lodge, Montana, a small mining town at the terminus of the Rock Fork Railroad, which is a side branch of the main line of the Northern Pacific. The outfit consisted of wagon and team, riding horses and other necessary equipments for such a trip. One assistant was employed, Mr. M. L. Jones, of Red Lodge, who not only acted as teamster and cook, but also rendered much assistance in collecting.

Our immediate destination, after leaving Red Lodge, was the extensive exposures lying to the south of the Gray Bull River in the vicinity of its junction with the Big Horn, some hundred and twenty-five miles from the point of starting. After crossing Stinking Water, we turned off the main stage road between Matutau and Red Lodge, and traveled east to the Old Bridge trail. In this region we met with a number of Wahsatch exposures, most of which are entirely barren. The few specimens we secured were very fragmentary.

Within less than a week we reached the Gray Bull River, but found it impassable on account of high water. While waiting for it to fall we examined the exposures upon the divide between the Gray Bull and Dry Creek to the north, and met with considerable success.

On the south side of the Gray Bull from near its mouth to a point twenty miles up the river are to be found the best exposures of the Big Horn Wahsatch. They extend from near the river south for a great distance, and while fossils cannot be said to be abundant at any point, yet careful search through these extensive exposures has resulted in a fairly good collection. It was in this locality therefore that the greater part of the summer was spent.

The examination of the beds within easy reach of the river was not difficult and collecting was comparatively easy, but when we came to extend our field to the more distant bad-lands, we encountered much greater difficulties. Scarcity of water was the greatest obstacle with which we had to contend, and it was only by dint of hard labor and much perseverance that we were able to accomplish the examination of these outlying sections.

Experience of former expeditions into this locality had taught me the necessity of being properly equipped for this emergency, and we accordingly provided ourselves with suitable casks for transporting water on the back of a pack-horse. Our usual method was to establish dry camps in the midst of the bad-lands where one man with a supply of fifteen or twenty gallons of water could subsist for a week or ten days without difficulty. At the expiration of this time he would have completed the examination of the exposures in his immediate vicinity, when his assistant would bring a fresh supply and move his camp into another place. In this way weeks were spent in a search for fossils in regions entirely destitute of water, and it may be said in passing, that some of our best specimens were secured in these places.

Generally the fossils were found washed out of the sediments so that little excavating was necessary. In some instances, however, they were found in the rock. For the most part ordinary methods of collecting were practiced, viz.: gathering up all the pieces and packing them properly for shipment, but the collection of some of the fossils deserves especial mention in view of the somewhat novel methods employed. Upon one occasion, while camped alone in the bad-lands, about fifteen miles from the main outfit, I came upon a few teeth which I at once recognized to be of unusual interest. They had washed out of a low sandstone bluff, leaving the point of the lower jaw still remaining. Search as carefully as I would I could not find more than the merest handful of fragments of bone and broken teeth, which were very unsatisfactory indeed. In washing out the fragments that had been deposited upon a level surface some twenty or thirty feet square, I was led to infer that the remaining fragments of perhaps the entire skull were covered up in the loose dirt. Acting upon this I carefully scraped up all the dirt and packed much of it out to the river in sacks on the back of a horse. Later we found a tolerably passable route for our wagon, and hauled it all to the river where we carefully washed it after the manner of the placer miner. In this manner, laborious as it was, we recovered almost the entire upper and lower maxillæ of the rare and hitherto little known genus *Palæonictis*. After cementing the fragments together we find that the entire dentition is present, together with some important parts of the skull. In this way, too, we recovered much of the skeleton of another Creodont (*Oxyæna lupina*), including the carpus and most of the foot bones, which have been hitherto entirely unknown. This simply serves to illustrate the care and energy that are often necessary on the part of the collector if he would meet with even an ordinary measure of success in this region, where anything like complete skeletons are very rare indeed.

Our first side trip was made into the bad-land exposures lying between Gray Bull and Stinking Water in the vicinity of the mouth of the latter stream. In so doing we passed over the old Bridger trail and met with many exposures, most of which were barren. Owing to the extreme scarcity of water, however, and the great distance we would have been compelled to carry it, we did not explore these exposures as thoroughly as we would have done had the circumstances been more favorable.

Our next trip was into the Buffalo basin which, as I have already said, is the upper or western part of the valley of Fifteen Mile Creek. These exposures pertain to a much higher level than those of either the Gray Bull or Stinking Water, being probably within 800 or 1000 feet of the top of the entire sedimentary mass. On this account we have kept all collections from this horizon separate from the rest.

Although these beds are mostly barren, we were able to secure a fair collection from them by dint of hard labor. The water and grass were extremely poor at the time of our visit, and it was with great difficulty that we could keep control of our animals. The water was, in fact, but little better than thin alkali mud, and in many instances literally swarmed with animal and vegetable life. Our best finds in these beds were some very good specimens of the peculiar genus *Anacodon*, together with those of Lemuroids, Rodents and Coryphodons.

Our last trip was into the Wind River basin to the south, and although we had comparatively little time at our disposal, and much traveling to do in order to reach this locality, we successfully accomplished the task, and returned after an absence of twenty days with some important specimens from this horizon to reward us for our efforts. The more or less complete skeletons of *Heptodon calciculus* and *Palæosyops borealis* were among the principal finds of this trip.

It was the work of but a few days to get our collections together, pack them properly and return to the point of starting, where we arrived after an absence in the bad-lands of nearly four months.

Article XII.—REVISION OF THE SPECIES OF CORYPHODON.

By CHARLES EARLE.

The recent expedition sent out by the American Museum of Natural History to the Bad Lands of the Wahsatch formation of Wyoming was successful in procuring some valuable Coryphodon material.

Through the kindness of Dr. H. F. Osborn, Curator, the entire collection has been placed in my hands for identification and study. In taking up the Coryphodontidæ, I am surprised by the great number of species which have been proposed, and I find upon studying and comparing the types that a great reduction in the number of species should be made.

Prof. Cope, with his usual liberality, has kindly allowed me to study his whole collection of Coryphodon material, therefore I am now prepared to revise the species approximately, and to give a fairly accurate diagnosis of each. Unfortunately nearly all the American material of *Coryphodon* has been found scattered, so that it is almost impossible to say what parts of the skeletons of the different individuals should be associated with each other.

The collection in the American Museum contains, among other specimens, the greater part of the skeleton of *Coryphodon anax* (=*Bathmodon pachypus* Cope), although there are no teeth associated with this specimen. There is also a very valuable specimen of *C. obliquus*. This latter is of importance, as it represents one individual, and contains the upper and lower dentition nearly complete.

Since Prof. Cope's original discovery[1] of the occurrence of the genus *Coryphodon* in America, he has described four new genera of the Coryphodontidæ from this country.

[1] Proc. Am. Phil. Soc., 1872, p. 417.

I am especially doubtful as to the validity of the genus *Bathmodon*, and shall consider it in this paper as a synonym of *Coryphodon*. The character upon which this genus was based—namely, the presence of a tibiale facet upon the astragalus, will, I believe, be found not to be confined alone to this genus of the Coryphodontidæ, but will prove to be one of the ordinal characters of the Amblypoda in general. The presence of a tibiale facet upon the astragalus is the general rule among the other members of the Amblypoda. Marsh[1] has noticed the presence of this facet in the Dinocerata. He also adds, "The astragalus in *Coryphodon* is very similar in form to that in the Dinocerata, but is shorter. It has essentially the same articular faces, and the facet for the tibiale is equally well marked."[2] Prof. Cope[3] has also pointed out the existence of a tibiale facet in the astragalus of the genus *Pantolambda*.

We see from the above that in all the genera of the Amblypoda, of which we possess good examples of the astragali, there is the common character of an internal tibiale facet.

The material referable to the tarsi of *Coryphodon* and allied genera in Prof. Cope's collection is very limited. He[4] has described a species of *Coryphodon*, named *C. latipes ;* associated with the skeleton, upon which this species is based, are two astragali. These are the only astragali in Prof. Cope's collection, which I find have been referred to the genus *Coryphodon* by him.

The two astragali above mentioned are much worn and rounded off, and as they are associated with other parts of a skeleton which shows decidedly juvenile characters, I believe that the whole skeleton belongs to an immature specimen of *Coryphodon*, in which it is impossible to form a conjecture as to the presence or absence of the tibiale facet.

I do not retain the genus *Metalophodon* Cope as a distinct genus, for the reason that all stages of transition occur, in which the posterior limb of the external crescent of the second superior molar is well developed, down to that in which the crest has

[1] Monograph of the Dinocerata, pp. 146 and 148.

[2] This description is not confirmed by Osborn.

[3] Tertiary Vertebrata, p. 612.

[4] Proc. Am. Phil. Soc., 1873, p. 33.

TABLE SHOWING ALL THE PROPOSED AMERICAN SPECIES OF CORYPHODON AND RELATED GENERA, WITH THEIR ORIGINAL NAMES, NATURE OF TYPE, AND LOCALITY.

NAME.	DATE.	TYPE.	FIGURE.	LOCALITY.
1. Bathmodon radians *Cope*.... ..	Proc. Am. Phil. Soc., Feb. 16, 1872, p. 417.	Sup. m. 2 & 3 with skeleton.	Tert'y Ver., pls. 45–57.	Evanston, Wy.
2. Bathmodon semicinctus *Cope*...	" " " " "	Teeth..................	....	" "
3. Metalophodon armatus *Cope*....	" " 1872, p. 542.......	Superior molars.........	Tert'y Ver., pl. 49....	Black Butte,"
4. Metalophodon testis *Cope*......	" " 1881, p. 175.......	" "	" " pl. 44 a...	Big Horn.
5. Bathmodon latipes *Cope*........	" " 1873, p. 33........	Skeleton................	" " pl. 48....	Evanston, Wy.
6. Bathmodon elephantopus *Cope*..	Rep. Vert. Fos. N. M., Wheeler, 1874, p. 10.	Last sup. and inf. m. 3...	Pal. of N.M., pls. 50–54.	New Mexico.
7. Bathmodon simus *Cope*........	" " " " p. 8..	Inferior molars..........	" " pl. 55....	" "
8. Bathmodon lomas *Cope*........	" " " " p. 9..	Inferior molar 3.........	" " pl. 54....	" "
9. Bathmodon molestus *Cope*......	" " " " "	Sup. and inf. molars......	" " pls. 56–57.	" "
10. Bathmodon latidens *Cope*......	Syst. Cat. Vert. N. M., 1875, p. 29........	Jaw with teeth..........	" " pls. 48–50.	" "
11. Bathmodon cuspidatus *Cope*....	" " " p. 30...	Inferior molar 3.........	" " pl. 46....	" "
12. Coryphodon hamatus *Marsh*...	Am. Jour. Sci. & Arts, 1876, p. 426........	Sup. and inf. molars.	Mon. of Dinocerata, p. 52.	Wyoming.
13. Coryphodon obliquus *Cope*.....	Pal. of New Mexico, Wheeler, 1877, p. 207.	" " "	Vert. Pal. N. M., pl. 47.	New Mexico.
14. Coryphodon lobatus *Cope*.....	" " " " p. 209.	" " "	" " pl. 46.	" "
15. Coryphodon repandus *Cope*.....	Proc. Am. Phil. Soc., 1881, p. 171........	Inferior m. 2 and 3.......	Tertiary Vert., pl. 44e.	Big Horn.
16. Coryphodon curvicristis *Cope*...	" " " p. 172........	Sup. m. 2 & mand. with teeth.	" " pl. 44c.	" "
17. Coryphodon marginatus *Cope*...	" " " p. 174........	Superior molar 3.........	" " pl. 44e.	" "
18. Coryphodon anax *Cope*........	" " 1881 (1882), p. 168..	Sup. and inf. molars......	" " pls. 44a–e.	" "
19. Bathmodon pachypus *Cope*.....	Proc. Acad. Nat. Sci. Phila., 1882, p. 294..	Skeleton................	" " pls. 44d–g.	" "
20. Manteodon subquadratus *Cope*..	Proc. Am. Phil. Soc., Dec. 16, 1881.......	Last sup. m. with incisors.	" " pl. 44a.	" "
21. Ectacodon cinctus *Cope*........	" " " " p. 167..	Superior molars.........	" " "	" "

nearly disappeared.[1] In fact the absence or presence of the posterior limb of the crescent in *Coryphodon* is largely dependent upon the amount of abrasion, for as the tooth becomes more worn it involves the posterior limb of the crescent. This abrasion first affects the external portion of the posterior limb, and further wear will bring it into continuity with the internal apex of the crescent.

Variations and Homologies of the Molar Teeth.

Before taking up the descriptive part of this paper, I propose to treat some of the variations of the teeth and of the homologies of the molar cusps.

I have found it extremely difficult to define the limits of the specific groups in this genus, as in so many cases the species run into each other by insensible gradations. I have for that reason decided to reduce the species described to about half the number originally proposed.

The canine teeth show a great amount of variation as to size, and this is probably due partly to age and sex. The inferior canines associated with the type of *C. anax* are very much larger than those of *C. radians*, although the inferior molar series of these two species are nearly of the same size.

In no case have I been able to find two series of teeth of the same species which are even closely similar in size, etc. They always vary in their dimensions and in the characters of the crest of the last superior and inferior molars. For example, in *C. elephantopus*, Cope mentions the fact that in his specimen the last superior molar exhibits traces of the posterior limb to the crescent, whereas in the specimen in the American Museum collection this tooth is without this rudimentary limb, although in all the other characters our series of teeth correspond exactly to those of the type in the Cope collection. This same variation exists in *C. radians*, as already mentioned; now if we are to interpret all these variations as specific, the list of species in this genus would increase indefinitely. I therefore, in limiting the species, have summed up the characters in all cases when comparing related species, and have not considered slight variations as specific.

[1] See Marsh's figures of *Coryphodon*, Monograph of the Dinocerata, p. 52.

The structure of the crescent in the second superior molar is an extremely variable character, and when we compare the series of species from *C. radians* through *C. elephantopus* to *C. hamatus*, I am sure we can find no generic characters between them, but must recognize the fact that we are here dealing with a phyletic series in which, in the first-named species, we have the crescent well developed, down to that where the posterior limb is completely lost. In *C. radians* the form of the second superior molar and characters of the external crescent appear to be fairly constant, but in the last upper tooth of the superior series the case is different. There is, however, one character of this tooth which appears to be diagnostic of the species, and that is the relations of the external portion of the anterior crest to the basal part of the molar; in this species the anterior crest divides into two branches running externally to the base of the crown. The fine series of teeth (No. 274) in the American Museum collection exhibits this character very well, although the form of the last superior molar is different from the type specimen.

The great variation shown by the facets of the astragalus and calcaneum will be described later, and I believe it is not possible at present to diagnose any species upon these variable characters.

The variations shown by the long bones of the skeleton are many; they chiefly affect their length and the size of their distal and proximal extremities.

Homologies of the Cusps.—The homologies of the dental elements of the superior true molars of the Coryphodontidæ are not determined without considerable difficulty, and only by a comparison of the teeth of *Coryphodon* with the most primitive member of this group, namely *Pantolambda*, are we enabled to understand the structure of the type of molar found in *Coryphodon*. Prof. Cope[1] has studied the question of the homologies of the cusps in the Coryphodontidæ, and it appears to me that his conclusions are satisfactory. He finds that the tritubercular form of superior molar, as found in *Pantolambda*, was the probable starting point for the Coryphodon molar. In the former genus (Fig. 2 *A*) both external crescents are well developed, and there is a prominent parastyle or antero-external buttress.

[1] American Naturalist, 1884–85, pp. 1115 and 1195.

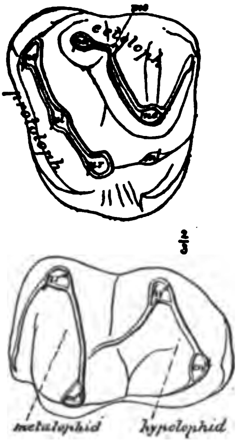

Fig. 1. The Morphology of an upper and lower Molar of Coryphodon. *pa*, paracone; *me*, metacone; *pr*, protocone; *ps*, parastyle; *ms*, mesostyle; *pl*, protoconule; *ml*, metaconule; *prd*, protoconid; *hyd*, hypoconid; *end*, entoconid.

In some of the species of Coryphodon we find, as the external elements of the crown, on the first and second superior molar, a strongly-developed posterior crescent, and connected with the anterior limb of the crescent, a prominent conical cusp (Fig. 1, *pa*).

The question is: what is the homologue of this cusp in *Pantolambda* and other Ungulates? Prof. Cope believes that this cusp is the sole representative of the anterior crescent of *Pantolambda*. On the second and last superior molars of *Coryphodon* the rudimentary anterior crescent is reduced to a cusp; but on the first molar this cusp is much elongated, and forms a short crest.

The Coryphodon molar still retains the large parastyle which is so characteristic of the teeth of *Pantolambda*. The mesostyle (Fig. 1, *ms*) in *Coryphodon* is only slightly developed, and is more prominent on the second superior molar than on any of the others.

The anterior transverse crest or protoloph in *Coryphodon* has probably been developed from the crest running externally from the protocone of *Pantolambda*.

It is very interesting to observe that in some species of *Coryphodon* the protoloph is enlarged at its middle, this enlargement being the homologue of the protoconule. Traces are also present of the metaconule.

The most primitive condition of the last inferior molar in *Coryphodon* is probably where the heel has a straight posterior border, for this is the condition in *Pantolambda*.

In *Coryphodon obliquus* we see the origin of the internal ridge or tubercle, which, as it increases in size, forces the entoconid to take the place of the fifth lobe of other forms, but the last inferior molar of *Coryphodon* has no element homologous with the hypoconulid or fifth lobe of the true Lophodonts.

The *Coryphodon anax* type shows the greatest specialization in the structure of the heel of the last inferior molar. In this species the three lobes of the heel are very large and equal in size.

It is interesting to note that the *Pantolambda-Coryphodon* line was first introduced by the tritubercular type of molar; later, however, in the Wahsatch period this line probably divided into two sublines, one leading to *Manteodon*, the other to *Coryphodon*. The first subline is characterized by the quadritubercular form of molar; in the last, however, the tritubercular type persisted.

Revised Table of Species and Synonyms.

	SPECIES.	SYNONYMS.
1.	Coryphodon radians...............	= C. repandus.
2.	Coryphodon testis.................	= Metalophodon testis.
3.	Coryphodon elephantopus..........	= C. simus, C. molestus, B. lomas,
4.	Coryphodon cuspidatus.	(C. latidens?), C. hamatus?
5.	(Coryphodon hamatus.)	
6.	Coryphodon obliquus.	
7.	Coryphodon curvicristis.	
8.	Coryphodon anax.........	= Bathmodon pachypus, Coryphodon lobatus.
9.	Manteodon subquadratus.	
10.	Ectacodon cinctus.	

Coryphodon *Owen.*

SYN.—*Bathmodon* Cope. *Metalophodon* Cope.

Premolars simpler than molars. Superior premolars, except first, consisting of an external and an internal crescent. Inferior premolars with only one crescent. Last inferior premolar much simpler than first true molar. Superior molars tritubercular, antero-external cone (parastyle) connected with protocone by a strong crest. First superior molar with well-developed postero-external crescent, second superior molar with crescent complete or incomplete. Last superior molar with crescent reduced to a posterior crest. Mesostyle well marked. Inferior true molars consisting of two crescents with anterior limb of each much reduced; trigonid raised above heel. Elements of heel of last inferior molar, entoconid and hypoconid; no cusp homologous with hypoconulid. No scapho-magnum articulation. Astragalo-cuboid contact large. Astragalus flat, with internal facet for tibiale.

Synoptical Table of the Genera and Species of Coryphodontidæ.

A. Last superior molar with postero-external crescent complete. Internal cones two (hypocone developed)................................*Manteodon*.
Hypocone smaller than protocone.....................*M. subquadratus*.

B. Last superior molar with postero-external crescent lacking posterior limb. Internal cones one (hypocone wanting, or rudimentary).....*Coryphodon*.

I. Second superior molar with external crescent complete.
  a. Heel of last inferior molar bilobate.
    1. Paracone and posterior crest of last superior molar in a straight line (type)....................................*C. radians.*
    2. Paracone and posterior crest of last superior molar forming a right angle..............................*C. elephantopus.*
  b. Heel unknown. Last superior molar with postero-external cusp. *C.* (*Ectacodon*) *cinctus.*
  c. Heel of last inferior molar trilobate.
    1. Accessory tubercle in posterior valley a cusp (bunoid). Size small.................................*C. cuspidatus.*
    2. Accessory tubercle in posterior valley a lobe (lophoid).
       Size large. Sup. m. 3 subtriangular ....*C. anax.*
       Size small. Sup. m. 3 oval.....................*C. obliquus.*
  d. Heel of last inferior molar forming a crest (hypoconid and entoconid continuous)...................................*C. curvicristis.*

II. Second superior molar with external crescent incomplete.
  e. Heel of last inferior molar unknown. Sup. m. 2 with posterior limb of crescent reduced...............*C.* (*Metalophodon*) *testis.*
  f. Heel of last inferior molar bilobate. Sup. m. 2 with posterior limb of crescent wanting...............................*C. hamatus.*

Coryphodon radians *Cope.*

SYN.—*Coryphodon repandus* Cope.

Last superior molar subtriangular in outline, external termination of anterior crest generally in continuity by two ridges with basal portion of crown; postero-external crest oblique and connected with posterior cingulum by a sharp ridge (type). Last inferior molar with heel bilobate.

The type specimen of *C. radians* (Fig. 2, *B*, p. 159) consists of the last two superior molars with upper premolars, and lastly of an astragalus, femur, and other fragments of the skeleton.

The specimens in Prof. Cope's collection upon which he based his *C. repandus* are two superior molars and a portion of a jaw bearing the last two molars, all from the same individual. The measurement and character of these teeth are almost identical with the type specimen of *C. radians*, and for that reason I believe they should be referred to that species. The difference in character of the posterior crest of the last superior molar in the two types is largely due to the condition of wear, and I think are not specific.

Coryphodon radians was the first American species of this genus described. Prof. Cope[1] at the time of the discovery

[1] Proc. Am. Phil. Soc., 1872, p. 417.

of this species referred it to a new genus *Bathmodon*. Later he[1] recognized the fact that *Bathmodon* was identical with the European genus *Coryphodon*, and in his subsequent work on the 'Extinct Vertebrata of New Mexico' (1877), described this species and many others under the name of *Coryphodon*. In his 'Tertiary Vertebrata'[2] Prof. Cope again separated *Bathmodon* from *Coryphodon*, basing the differential characters of the genus upon the presence of an internal facet on the astragalus for the tibiale. As already mentioned, I cannot recognize this character as generic, but believe that it is common to the order Amblypoda. The original material from which *C. radians* was described came from Evanston, Wyoming. Prof. Cope states that later he procured a mandible from the same locality, which he supposed belonged to this species. I believe he is correct in associating the form of last inferior molar with a bilobate heel with the type of *C. radians*. Another reason for supposing this association to be correct, is the fact that the type specimen of *C. repandus* includes both upper and lower teeth from the same individual; also in this species the heel of the last inferior molar has a straight posterior border. If I am correct in supposing that *C. repandus* is the same species as *C. radians*, then the posterior limb of the crescent of the last superior molar is a variable character, as the type specimen of *C. repandus* shows none.

I consider also that *C. radians* and *C. anax* are very closely related species, and that *C. anax* may not be specifically distinct; this is shown by the fact that the inferior molar series of the two species are nearly of the same size. The internal tubercle, which is so characteristic of the last inferior molar of *C. anax*, is quite variable in size and position. There are three jaws in Prof. Cope's collection, two of which he refers to *C. anax*; in one (No. 2) the dimensions of the dental series are less than in the type of *C. radians*, and in this jaw the internal tubercle of the last inferior molar is not as much separated from the median tubercle as in the type specimen. The last upper molar of the type of *C. radians*, however, is smaller than that of *C. anax*.

[1] Pal. Bull., No. 21, April 11, 1876, p. 2.
[2] Tertiary Vertebrata, 1884, p. 544.

Measurements of Jaws.

	C. anax, No. 1.	*C. anax*, No. 2.	*C. radians*.
	M.	M.	M.
Entire length of jaw..............	.420	.370	
Molar series, total................	.195	.170	.195
Depth of jaw below m. 2............	.085	.070	.070
Length inferior m. 3	.044	....	.043

The astragalus which Prof. Cope has associated with the type of *C. radians* is much smaller than that of *B. pachypus*, and it is strange that such is the case, as the teeth of *C. radians*, at least the lower ones, are nearly as large as those of *C. anax* (= *B. pachypus*). The astragalus of *C. radians* is nearly square in its dimensions; the tibiale facet is very large, and placed at right angles to the navicular face of the bone. This facet is separated by a notch from the superior face of the astragalus, although I believe this to be a variable character. Also in this astragalus the groove between the sustentacular and ectal facets is continued posteriorly into a foramen which opens above. This is probably another variable character, and will be more fully considered under the head of *C. anax*.

A few species of *Coryphodon* have been recorded from the Wind River. Prof. Cope[1] includes two species from this formation, namely: *C. radians* and *C. cuspidatus*. Among the collection of specimens brought from the Wind River by Dr. Wortman, there are fragments of a skeleton of a species of *Coryphodon*, including a few teeth fairly well preserved. These teeth are of the last of the lower series, and compare nearly in size and character with those of *C. radians*. I therefore provisionally refer them to this species.

Coryphodon testis *Cope.*

SYN.—*Metalophodon testis* Cope.

Second superior molar much larger than the last; posterior limb of crescent reduced to an external cusp. Last upper molar oval in outline with posterior crest straight.

[1] On the Vertebrata of the Wind River Eocene Beds of Wyoming. Bull. U. S. Geol. Surv., 1881, p. 183.

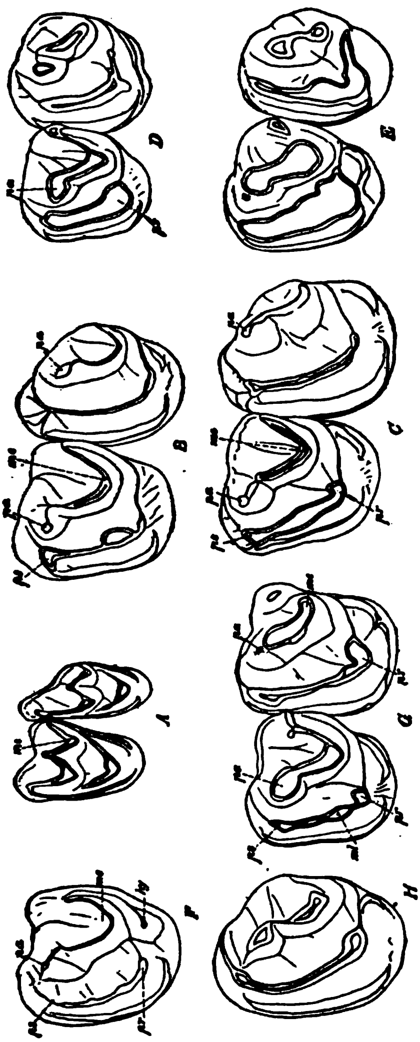

FIG. 2. Comparative view of second and third upper molars of Coryphodon. *A*, *Pantolambda*, ⅔ natural size. All others ½ natural size. *B*, *C. radians*, type. *C*, *C. radians*. *D*, *C. elephantopus*. *E*, *C. testis*, type. *F*, *Manteodon subquadratus*, type. *G*, *Ectacodon cinctus*, type. *H*, *C. anax*, type.

The type of *C. testis* is a beautiful series of the maxillary teeth of both sides in Prof. Cope's collection (Fig. 2, *E*). Prof. Cope[1] originally described the genus *Metalophodon* from two series of teeth,[2] one mature, the other a series of milk teeth, which were found in the same locality, although from different skulls. These teeth are in such a poor state of preservation, and as the last two upper molars of the mature specimen are of the same size and character, I cannot consider them as good types. In the Coryphodontidæ the second superior molar always differs widely in form and characters from the last, and I have yet to see an exception to this rule.

The exceedingly fine type specimen of *C. testis* has the second superior molar much larger, and every way different in character from the last. The posterior limb of the crescent in this molar has only its external portion worn, although further

[1] Proc. Am. Phil. Soc., 1872, p. 542.
[2] Tertiary Vertebrata, pl. xlix.

abrasion would probably have brought the whole limb in continuity internally with the apex of the crescent. The last superior molar of this species is oval in outline, with no postero-external enlargement such as is characteristic of the *C. elephantopus*.

Coryphodon elephantopus *Cope.*

SYN.—*C. simus*, *C. molestus*, (*C. latidens?*), *B. lomas*.

Last superior molar with postero-external portion prolonged beyond crest; external part of posterior crest forming a right angle with the internal.

The type of *C. elephantopus* described by Prof. Cope[1] is a last superior and inferior molar. Later in his 'Extinct Vertebrata of New Mexico,' he described the finely-preserved skull with teeth which is figured in this work (Fig. 2, *D*).

I refer specimen No. 275 in the American Museum collection to this species, although its teeth differ in some of their characters from those described by Prof. Cope; this difference consisting in the fact that the last superior molar shows no trace of a posterior limb to the external crescent; otherwise the measurements and characters of the teeth are identical. I have shown elsewhere that this character is a variable one in *C. radians*, and will not suffice for specific definition.

Prof. Cope recognizes three other species of *Coryphodon* which are closely related to *C. elephantopus;* these are the *C. simus*, *C. molestus* and *C. latidens*.

The material pertaining to *C. molestus* is abundantly represented in Prof. Cope's collection, and numerous figures are given in the work above cited.

The type of *C. simus* is a lower jaw with teeth. In this specimen the last inferior molar is preserved, whereas in the type of the lower jaw of *C. elephantopus* this tooth is wanting. The teeth of *C. simus* are slightly smaller than those of *C. elephantopus*, otherwise I see no distinction between them.

The *C. latidens* was established upon the well-preserved mandible with teeth figured in the 'Extinct Vertebrata of New Mexico."[2] In this specimen the last inferior molar is also preserved, and

[1] Report of Vert. Fossils N. M., Wheeler, 1874, p. 10.

[2] Vertebrate Palæontology of New Mexico, Wheeler, 1877, pl. xlviii.

differs quite radically in form from that of the type of *C. simus.* The measurements of the lower teeth of *C. latidens* correspond exactly with the superior molars of *C. elephantopus*, and for that reason I do not give it specific rank, although further material may show that *C. latidens* is a good species.

There is another reason for referring *C. latidens* to *C. elephantopus.* In the former species the last inferior molar of the type specimen has a straight heel, with no trace of the posterior enlargement which is so characteristic of the *C. anax* and the more specialized species. Now the square form of the last superior molar of *C. elephantopus* should, I believe, be associated, as in *C. radians*, with a last inferior molar which has a bilobate heel. I have positive proof from a specimen in the American Museum collection that the oval form of last superior molar is associated with the trilobate heel.

I have labored under the disadvantage of not being able to study any of the types of *Coryphodon* from New Mexico, which have been described by Prof. Cope. Accordingly some of my conclusions as to the synonyms of the species may be incorrect; however, I can hardly appreciate the specific distinctions, made by Prof. Cope, between many of the Wahsatch species from New Mexico.

Coryphodon cuspidatus *Cope.*

Last inferior molar with a prominent conical tubercle on internal side of heel.

This is a smaller species of the genus, and closely related to *C. obliquus;* it was established upon a posterior portion of a last inferior molar from New Mexico.

The tubercles and ridges on the last inferior molar of this species of *Coryphodon* are exceedingly variable characters. In the collection of the American Museum there is a series of lower molars of *C. radians*, and on the external side of each last molar there is a prominent tubercle between the lobes. I should hardly venture to refer this specimen to a new species based upon this character, and believe it to be merely a variation from the typical form of molar found in *C. radians.*

Coryphodon hamatus *Marsh.*

Superior true molars broad and short as in *C. elephantopus*. Second superior molar with posterior limb of crescent absent.

I describe the characters of this species from the figure of its dentition given by Marsh.[1] If this be correct we have the most specialized species of the genus, as in this form the posterior limb of the crescent of superior *m* 2, as figured, is totally absent. The form of the last superior molar is like that of *C. elephantopus*, and it is important to notice that this specimen is associated with the bilobate form of last inferior molar. The dimensions of the teeth in *C. hamatus* are the same as in *C. elephantopus*, and it may prove to be the same species. Flower and Lydekker[2] in their new work on the 'Mammalia' have incorrectly given Marsh's name of *C. hamatus* priority over that of *C. elephantopus* Cope.

Coryphodon obliquus *Cope.*

Last superior molar an elongated oval. Heel of last inferior molar trilobate; its internal enlargement a ridge.

The type of *C. obliquus* is a portion of a mandible bearing the last two molars, from New Mexico. This species has not been before recorded from the Big Horn Wahsatch. We are fortunate in having a fine specimen of it in the collection (No. 276) from this locality, consisting of the superior molar series with the mandibular dentition nearly complete.

It is exceptional to find together the superior and inferior molars of any of the species of *Coryphodon*. However, the specimens of *C. obliquus* in the American Museum collection are from one individual, and on that account they are of special value.

This is one of the few species of *Coryphodon* which can be readily distinguished by its size and dental characters from the larger species of the genus. The much smaller size of the teeth, the narrow and elongated form of the last upper molar with its long posterior crest readily distinguishes it from *C. anax*.

The second superior molar in *C. obliquus* has the posterior limb of the crescent well developed. The last lower molar is longer

[1] Dinocerata, 1884, p. 54.

[2] Mammals, Living and Extinct, Flower and Lydekker, 1891, p. 438, fig. 191.

than broad, its posterior crest is oblique to the anterior. The heel of this tooth has the entoconid large, and internally it becomes continuous with the low tuberculated ridge characteristic of the species.

The ramus of the mandible is much elongated and slender. The symphysis is long and strongly procumbent.

Measurements of Teeth and Jaw in C. obliquus.

		M.
Entire superior molar series		.136
Superior molar 3	ant. post.	.024
	trans.	.037
Entire inferior molar series		.152
Inferior molar 3	ant. post.	.037
	trans.	.022
Entire length of jaw		.330
Depth of jaw below middle of m. 3		.057

Coryphodon curvicristis *Cope.*

Heel of last inferior molar with crest extending inwards from hypoconid; no entoconid differentiated. Superior incisors with prominent external rib.

The type of *C. curvicristis* is a second superior molar, a canine and a mandible of one side containing all the true molars intact. These specimens are from the Big Horn.

This species is of the same size approximately as *C. obliquus*, and is one of the most distinct of the genus. The peculiar character of the heel of the last inferior molar exists in no other known species; the anterior limb of the heel is strongly marked. The crowns of the lower teeth are higher in proportion to their length than in the allied species. The second superior molar, associated with the type specimens, is intermediate in size between that of *C. anax* and *C. obliquus;* its external crescent is high and turned strongly toward the posterior border of the tooth. A canine belonging to this species is much elongated, sharp and triangular in section.

A form of *Coryphodon* described by Prof. Cope as *C. marginatus* I cannot admit as a good species. The teeth upon which it was established are probably from the milk dentition. The characters of the upper molar of this type show that it may pertain to the milk series of *C. anax*.

Coryphodon anax *Cope.*

SYN.—*Bathmodon pachypus* Cope, and *Coryphodon lobatus* Cope.

Last superior molar oval in outline; external portion of anterior crest not connected with basal part of tooth by two ridges. Heel of last inferior molar trilobate in structure, with lobes nearly equal in size.

The largest known species of *Coryphodon*, namely, the *B. pachypus*, was established[1] upon the characters of the skeleton alone. The type of *C. anax* has both upper and lower molars (Fig. 2, *C* and *H*) associated with parts of the skeleton. I consider, as both of these types are from the same locality, and as the differential characters pointed out by Prof. Cope[2] are variable, that these two species are probably identical. I have compared parts of the skeleton of the specimen of the large species of *Coryphodon* in the American Museum collection with the type of *B. pachypus*, and find they correspond.

The last upper molar of *C. anax* (Fig. 2, *H*) is large and much extended transversely; it can be distinguished from that of *C. radians* by its larger size, and also from the fact that, in the type specimen, the anterior transverse crest at its external extremity is not bifid. Although this character may be variable, as shown by the specimen (No. 267) in the American Museum collection. The valley in the last superior molar separating the paracone from the anterior crest is not as deep as in *C. radians;* also the anterior limb of the external crescent is more oblique and crescentoid than in the latter species. The form of the last inferior molar is highly characteristic of *C. anax;* its heel is strongly trilobate, and the median lobe is well separated from the laterals. The size of this tooth, as already observed, is not larger than in some specimens of *C. radians*. Prof. Cope attempts to distinguish *C. anax* from *B. pachypus*, among other characters, upon the form of the facets of the astragalus and calcaneum. In the American Museum specimen (No. 258) the astragalus is the same size as in the type specimen of *B. pachypus* in Prof. Cope's collection. In this specimen the tibiale facet of the astragalus is well marked, but is discontinuous with the navicular; in this respect it resembles *C. radians*, and differs from the type specimen. The large size of the astragalus of *C. anax*, and especially its greater transverse extent, distinguishes it from that of *C. radians*.

[1] Proc. Acad. Nat. Sci. Phila., 1882, p. 294.

[2] Tertiary Vertebrata, pp. 551, 552.

The characters of the calcaneum mentioned by Cope as separating the two species will not hold good. In the American Museum collection there are three series of astragali and calcanea of *C. anax;* in the best-preserved specimen (No. 258) the sustentacular facet has an anterior prolongation; whereas in No. 273 the anterior portion is entirely absent. The sustentaculum in this specimen is of an oval form.

I have examined four sets of the astragali and calcanea of *C. anax*, and find that the characters of the inferior face of the astragalus are quite constant; I refer especially to the groove and foramen which are always placed on the astragalus between the ectal and sustentacular facets. In three specimens of the four the posterior opening of the groove is shut off by a bridge of bone connecting the ectal facet with the posterior median enlargement of the astragalus. In one specimen in the collection the bridge of bone is absent, and consequently there is a well-marked foramen; this specimen is associated with a calcaneum, in which the sustentacular facet is elongated.

The beautifully preserved pelvis in the American Museum collection has the same dimensions as that belonging to the type of *B. pachypus;* the femur, however, which is associated with it, is much smaller than that of *B. pachypus*. It is interesting to note that the American Museum femur has the same dimensions as that referred by Cope to the *C. anax*, thus offering more proof that *C. anax* and *B. pachypus* are the same species.

Manteodon subquadratus *Cope*.

Last superior molar quadrate in form; hypocone smaller than protocone; paracone compressed and elongated.

The genus *Manteodon* was established by Prof. Cope[1] upon an upper true molar (Fig. 2, *F*) with fragments of teeth. I think Prof. Cope has correctly identified the single superior molar associated with the type as the last one of the superior series. We have in this tooth interesting characters which show us the modifications through which the *Coryphodon* molar has undergone. The fact that the last superior molar of *Manteodon* is quadritubercular in structure is unique, and occurs in no other genus of this family. This may indicate that *Manteodon* is not in the direct

[1] Proc. Am. Phil. Soc., 1881, p. 166.

line to *Coryphodon;* as in this case we should have to suppose the loss of the hypocone. The nearest approach to the rudiment of a hypocone on the superior molars of *Coryphodon* occurs in the *C. elephantopus*, although Marsh's figure of his *C. hamatus* probably indicates the presence of this cone in a rudimentary condition.

Ectacodon cinctus *Cope*.

Last superior molar rectangular, larger than second; postero-external cusp widely separated from posterior crest.

The type of this genus and species is a finely-preserved series of upper molars in Prof. Cope's collection.

In the *E. cinctus* (Fig. 2, *G*) the anterior crest of the last upper molar is high, and its external termination is connected with the basal portion of the crown by only one ridge. The internal cingulum of this tooth is complete. In the second upper molar the external termination to the posterior limb of the crescent forms a prominent cusp, which is homologous with the postero-external cusp of the second superior molar of *C. testis*.

In this tooth the crescent is complete, and not reduced as in the latter.

This species is more closely related to *C. radians* than to any other, this being shown by the fact that in *C. radians* the last superior molar has traces of the posterior limb to the crescent; the postero-external cusp of *Ectacodon* being the remains of this posterior limb in the latter species.

C. elephantopus approaches the *E. cinctus* in the nearly square form of its last superior molar, but lacks the postero-external cusp of the latter.

I am doubtful whether *Ectacodon* should hold a generic rank, but as there are no direct transition forms as yet known between it and *Coryphodon* I retain it for the present.

In conclusion I wish to add, that owing to the material referable to the species of *Coryphodon* having been, in most cases, found so widely dissociated, it has been impossible to state accurately their number. I am convinced that the large number of species which have been founded by Prof. Cope should be greatly reduced; and that in many cases his species are to be considered merely varieties, and that often these varieties are merely individual variations in the same species due to age and sex.

Article XIII.—LIST OF TYPES OF LEPIDOPTERA IN THE EDWARDS COLLECTION OF INSECTS.

By William Beutenmüller.

The object of the present paper is to place on record a list of the types of Lepidoptera in the collection of insects formed by the late Henry Edwards, which is now the property of the Museum. The collection consists of about 250,000 specimens and about 25,000 species, representing all the orders, and gathered in various parts of the globe. It is especially rich in Australian species, and in North American species from the Pacific Coast. A large number of Lepidoptera from this country were described by Mr. Edwards, and most of his types are in the collection, as well as many types of species described by other writers. The following list enumerates 465 species, which, together with the list[1] of 70 types from the Grote and Robinson collection, already recorded, aggregates 535 species of Lepidoptera, the types of which are now in the Museum collection. *Catocala angusii* Gr., *Catocala residua* Gr., *Attacus cinctus* Tepper, mentioned in the present list, are from the collection of insects recently donated to the Museum by James Angus, Esq.; and *Euclea elliotii* Pears. is from the Elliot collection, otherwise all are in the Edwards collection.

PAPILIONIDÆ.

Papilio pergamus *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 423.—One male, Santa Barbara, Cal.

Parnassius clodius var. **menetriesii** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 164.—Male and female, Sierra Nevada, Cal.

Parnassius smintheus var. **hermodur** *Hy. Edw.*, Papilio, Vol. I, p. 4.—Two females, Southern Colorado.

Parnassius eversmanni var. **thor** *Hy. Edw.*, Papilio, Vol. I, p. 2.—One female, Yukon River, Alaska.

[1] Bull. Am. Mus. Nat. Hist., Vol. IV, pp. 59–64.

Anthocharis ausonides var. **coloradensis** *Hy. Edw.*, Papilio, Vol. I, p. 50.—Male and female, Colorado.

Colias harfordii *Hy. Edw.*, Proc. Cal. Acad. Sc., Feb. 5, 1877.—Five males, California.

Colias chrysomelas *Hy. Edw.*, Proc. Cal. Acad. Sc., Feb. 5, 1877.—Two males, Napa Co., Cal.

Colias barbara *Hy. Edw.*, Proc. Cal. Acad. Sc., Feb 5, 1877.—Two females, Santa Barbara, Cal. (=*C. harfordii*, ♀.)

Colias eurydice var. **amorphæ** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 169.—One male, Mendocino Co., Cal.

Colias moina *Strk.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 34.—Two females, Labrador.

Colias interior var. **laurentina** *Scud.*, Proc. Boston Soc. Nat. Hist., Vol. XVIII, p. 189.—One female, Cape Breton Island.

NYMPHALIDÆ.

Argynnis liliana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 170.—Three males, two females, Napa Co., Cal.

Argynnis columbia *Hy. Edw.*, Proc. Cal. Acad. Sc., Dec. 17, 1877.—Two males, British Columbia.

Argynnis bischoffii *Edw.*, Trans. Am. Ent. Soc., Vol. III, p. 189.—One female, Alaska.

Argynnis opis *Edw.*, Trans. Am. Ent. Soc., Vol. V, p. 105.—One female, British Columbia.

Argynnis monticola var. **purpurascens** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 170.—Three males, two females, Mt. Shasta, Cal.

Melitæa rubicunda *Hy. Edw.*, Papilio, Vol. I, p. 52.—Four males, three females, Sierra Nevada, Cal.

Melitæa chalcedon var. **dwinellei** *Hy. Edw.*, Papilio, Vol. I, p. 51.—Four examples, Shasta Co., Cal.

Melitæa nubigena var. **wheeleri** *Hy. Edw.*, Papilio, Vol. I, p. 52.—Male and female, Southern Nevada.

Melitæa leanira var. **obsoleta** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 171.—Four examples, Marin Co., Cal.

Limenitis lorquinii var. **eavesii** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 172.—One example, Virginia City, Nevada.

Cœnonympha california var. **eryngii** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 172.—Three examples, Mt. Shasta, Cal.

Cœnonympha california var. **pulla** *Hy. Edw.*, Papilio, Vol. I, p. 51.—One male, San Mateo, Cal.

LYCÆNIDÆ.

Thecla melinus var. **pudica** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 172.—One male, Contra Costa Co., Cal.

Thecla putnami *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 143.—One specimen, in poor condition, Utah.

Thecla spadix *Hy. Edw.*, Papilio, Vol. I, p. 53.—Two females, Tehachepi Pass, Southern California.

Thecla sæpium var. **fulvescens** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 172.—Two examples, Havilah, Cal. One example, Tehachepi Pass, Cal.

Thecla nelsoni var. **exoleta** *Hy. Edw.*, Papilio, Vol. I, p. 53.—Two females, Big Tree, Calaveras Co., Cal.

Thecla nelsoni var. **muiri** *Hy. Edw.*, Papilio, Vol. I, p. 53.—Male and female, Mendocino Co., Cal.

Thecla adenostomatis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 144.—Two examples, Tehachepi Pass, Southern California.

Thecla irus var. **mossii** *Hy. Edw.*, Papilio, Vol. I, p. 54.—One male, Vancouver Island.

Lycæna clara *Hy. Edw.*, Proc. Cal. Acad. Sc., Dec. 17, 1877.—Three examples, Tehachepi Pass, Southern California.

Lycæna speciosa *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 173.—One male, Havilah, Kern Co., Cal.

SPHINGIDÆ.

Hemaris cynoglossum *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 88.—Three examples, California.

Hemaris rubens *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 88.—One male, Oregon.

Euproserpinus euterpe *Hy. Edw.*, Ent. Am., Vol. IV, p. 25.—One male, Southern California.

Smerinthus ophthalmicus var. **pallidulus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 91.—Four examples, California.

Triptogon modesta var. **occidentalis** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 92.—One female, California.

Phlegethontius cingulata var. **decolora** *Hy. Edw.*, Papilio, Vol. II, p. 11.—One male, Indian River, Florida.

Sphinx chersis var. **oreodaphne** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 93.—Male and female, St. Helena, Napa Co., California.

Sphinx perelegans *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 109.—One male, one female, Santa Clara Co., California.

Sphinx vancouverensis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 111.—One male, Big Tree, Cal. One female, Oregon.

Sphinx libocedrus *Hy. Edw.*, Papilio, Vol. I, p. 115.—One male, Prescott, Arizona.

Protoparce dilucida *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Four examples, Jalapa, Mexico.

Diludia languinosa *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Four examples, Jalapa, Mexico.

Isognathus inclitus *Hy. Edw.*, Ent. Am., Vol. III, p. 90.—Three examples, Jalapa, Mexico.

Chœrocampa turbata *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Three examples, Jalapa, Mexico.

ÆGERIDÆ.

Melittia snowii *Hy. Edw.*, Papilio, Vol. II, p. 53.—One male, Kansas.

Melittia gloriosa *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 71.—One female, California.

Melittia bergii *Hy. Edw.*, Papilio, Vol. III, p. 157.—One female, Buenos Ayres, S. A.

Larunda solituda *Hy. Edw.*, Papilio, Vol. I, p. 182.—One female, Western Kansas.

Trochilium simulans *Grote*, Bull. Brooklyn Ent. Soc., Vol. III, p. 78.—One female, Northern Illinois.

Trochilium pacificum *Hy. Edw.*, Papilio, Vol. I, p. 180.—Male and female, California.

Bembecia flavipes *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 76 (=*B. marginata* Harr.).—One male, one female, Long Island, N. Y.

Sciapteron robiniæ *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 72.—Three males, Virginia City, Nevada. One female, California.

Sciapteron admirandus *Hy. Edw.*, Papilio, Vol. II, p. 54.—One male, Texas.

Sciapteron denotata *Hy. Edw.*, Papilio, Vol. II, p. 55.—One male, two females, Montana.

Fatua palmii *Hy. Edw.*, Can. Ent., Vol. XIX, p. 145.—One female, Enterprise, Florida.

Harmonia morrisonii *Hy. Edw.*, Papilio, Vol. II, p. 54.—One male, Montana. One female, Missouri.

Albuna rubescens *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 76 (=*A. hylotomiformis* Walk.).—One female, Colorado.

Albuna tanaceti *Hy. Edw.*, Papilio, Vol. I, p. 188.—Four females, Colorado, Vancouver and California.

Albuna artemisiæ *Hy. Edw.*, Papilio, Vol. I, p. 187.—One male, Sierra Nevada, Cal.

Albuna montana *Hy. Edw.*, Papilio, Vol. I, p. 188.—Three females, Colorado.

Albuna vancouverensis *Hy. Edw.*, Papilio, Vol. I, p. 188.—Four males, three females, Colorado and Vancouver Island.

Albuna coloradensis *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Colorado.

Albuna torva *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Vancouver Island.

Albuna resplendens *Hy. Edw.*, Papilio, Vol. I, p. 186.—One male, California.

Albuna rutilans *Hy. Edw.*, Papilio, Vol. I, p. 186.—One female, Virginia City, Nevada.

Albuna rileyana *Hy. Edw.*, Papilio, Vol. I, p. 187.—One female, Cadet, Missouri.

Sannina exitiosa var. **fitchii** *Hy. Edw.*, Papilio, Vol. II, p. 55.—One female, Florida.

Ægeria inusitata *Hy. Edw.*, Papilio, Vol. I, p. 201.—One male, Andover, Mass.

Ægeria quercus *Hy. Edw.*, Papilio, Vol. II, p. 98.—One male, Fort Grant, Arizona.

Ægeria prosopis *Hy. Edw.*, Papilio, Vol. II, p. 99.—One male, Fort Grant, Arizona.

Ægeria bolteri *Hy. Edw.*, Papilio, Vol. III, p. 155.—One male, Northern Illinois.

Ægeria flava *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Colon, Isthmus of Panama.

Ægeria aurata *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Panama.

Ægeria novaroensis *Behrens*, Papilio, Vol. I, p. 199.—One male, one female, Soda Springs, Cal.

Ægeria lustrans *Grote*, Can. Ent., Vol. XII, p. 213.—One female, Ohio.

Ægeria saxifragæ *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Colorado.

Ægeria henshawii *Hy. Edw.*, Papilio, Vol. II, p. 56.—One female, Mingan Island, Labrador.

Ægeria corni *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Massachusetts.

Ægeria verecunda *Hy. Edw.*, Papilio, Vol. I, p. 190.—Two females, Colorado.

Ægeria lupini *Hy. Edw.*, Papilio, Vol. I, p. 192.—Three males, three females, California.

Ægeria impropria *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Sierra Nevada, Cal.

Ægeria sexfasciata *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Dallas, Texas.

Ægeria corusca *Hy. Edw.*, Papilio, Vol. I, p. 193.—Two males, Texas.

Ægeria consimilis *Hy. Edw.*, Papilio, Vol. I, p. 194.—One male, Dorchester, Mass.

Ægeria hyperici *Hy. Edw.*, Papilio, Vol. I, p. 195.—Two females, West Virginia.

Ægeria eupatorii *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Astoria, Long Island, N. Y.

Ægeria kœbelei *Hy. Edw.*, Papilio, Vol. I, p. 196.—One male, Tallahassee, Florida.

Ægeria washingtonia *Hy. Edw.*, Papilio, Vol. I, p. 197.—One male, Washington.

Ægeria neglecta *Hy. Edw.*, Papilio, Vol. I, p. 197.—One male, Olympia, Wash.

Ægeria imperfecta *Hy. Edw.*, Papilio, Vol. I, p. 198.—One male, Colorado.

Ægeria hemizonæ *Hy. Edw.*, Papilio, Vol. I, p. 198.—Three females, Nevada and California.

Ægeria senecioides *Hy. Edw.*, Papilio, Vol. I, p. 198.—One male, California.

Ægeria opalescens *Hy. Edw.*, Papilio, Vol. I, p. 199.—Two males, Colorado and Nevada.

Ægeria giliæ *Hy. Edw.*, Papilio, Vol. I, p. 200.—One female, Colorado.

Ægeria mimuli *Hy. Edw.*, Papilio, Vol. I, p. 200.—One male, Colorado.

Ægeria madariæ *Hy. Edw.*, Papilio, Vol. I, p. 201.—One male, one female, California.

Ægeria albicornis *Hy. Edw.*, Papilio, Vol. I, p. 201.—One female, Centre, New York.

Ægeria auropurpurea *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 72.—One male, Texas.

Pyrrhotænia polygoni *Hy. Edw.*, Papilio, Vol. I, p. 202.—One male, San Miguel, Cal.

Pyrrhotænia fragariæ *Hy. Edw.*, Papilio, Vol. I, p. 202.—Two examples, Colorado.

Pyrrhotænia helianthi *Hy. Edw.*, Papilio, Vol. I, p. 203.—One female, Soda Springs, Cal.

Pyrrhotænia achillæ *Hy. Edw.*, Papilio, Vol. I, p. 203.—One male, San Rafael, Cal.

Pyrrhotænia eremocarpi *Hy. Edw.*, Papilio, Vol. I, p. 203.—One male, Sierra Nevada, Cal.

Pyrrhotænia meadii *Hy. Edw.*, Papilio, Vol. I, p. 204.—Two males, Lake Tahoe, Cal.

Pyrrhotænia orthocarpi *Hy. Edw.*, Papilio, Vol. I, p. 204.—Three males, Washoe Lake, Nevada.

Pyrrhotænia behrensii *Hy. Edw.*, Papilio, Vol. II, p. 123.—Three males, Soda Springs, Cal.

Pyrrhotænia wittfeldii *Hy. Edw.*, Papilio, Vol. III, p. 156.—Two females, Indian River, Florida.

Pyrrhotænia animosa *Hy. Edw.*, Papilio, Vol. III, p. 156.—One male, one female, Arizona.

Pyrrhotænia elda *Hy. Edw.*, Ent. Am., Vol. I, p. 49.—Two females, Siskiyou Co., Cal.

Pyrrhotænia floridensis *Grote*, Can. Ent., Vol. VII, p. 14.—One male, Enterprise, Florida.

Carmenta sanborni *Hy. Edw.*, Papilio, Vol. I, p. 185.—One female, Andover, Mass.

Carmenta nigella *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 75.—One male, Western New York.

Zenodoxus heucheræ *Hy. Edw.*, Papilio, Vol. I, p. 205.—Four examples, Sierra Nevada, Cal.

Zenodoxus potentillæ *Hy. Edw.*, Papilio, Vol. I, p. 205.—Three examples, Sierra Nevada, Cal.

Zenodoxus canescens *Hy. Edw.*, Papilio, Vol. I, p. 205.—One female, Arkansas.

Zenodoxus maculipes *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 184.—One female, Texas.

ZYGÆNIDÆ.

Alypia matuta *Hy. Edw.*, Papilio, Vol. III, p. 33.—One male, Colorado.

Alypia wittfeldii *Hy. Edw.*, Papilio, Vol. III, p. 34.—Two males, one female, Indian River, Florida.

Alypia similis *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 14.—One female, California.

Alypia similis var. **conjuncta** *Hy. Edw.*, Papilio, Vol. III, p. 34.—One male, Contra Costa Co., Cal.

Alypia brannani *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 8.—One male, Sierra Nevada, Cal.

Pseudalypia crotchii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 111.—One female, San Diego, Cal.

Scepsis mathewi *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 184.—Three examples, Vancouver Island.

Scepsis gravis *Hy. Edw.*, Ent. Am., Vol. II, p. 8.—Three specimens, Mendocino Co., Cal.

Scepsis fulvicollis var. **pallens** *Hy. Edw.*, Ent. Am,, Vol. II, p. 8.—Four examples, Denver, Colorado.

Scepsis edwardsii *Grote*, Papilio, Vol. I, p. 4.—Male and female, Indian River, Florida.

Ctenucha walsinghamii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 112 (=*C. rubroscapis* Menet.).—One female, Fort Crook, Oregon.

Ctenucha imitata *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Three males, Jalapa, Mexico.

Ctenucha scepsiformis *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Four males, Jalapa, Mexico.

Ctenucha proxima *Hy. Edw.*, Papilio, Vol. IV, p. 14.—One female, Jalapa, Mexico.

Ctenucha modulata *Hy. Edw.*, Papilio, Vol. IV, p. 14.—One female, Jalapa, Mexico.

Ctenucha pyrrhoura *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 77 (=*C. harrisii* Bd.).—One male, Colorado.

Lycomorpha notha *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One male, Jalapa, Mexico.

Lycomorpha sinuata *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One female, Jalapa, Mexico.

Lycomorpha angusta *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—One male, Jalapa, Mexico.

Lycomorpha marginata *Hy. Edw.*, Papilio, Vol. IV, p. 13.—One male, Mexico.

Lycomorpha coccinea *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—Two females, Arizona.

Gnophæla vermiculata var. **continua** *Hy. Edw.*, Papilio, Vol. I, p. 80.—Two examples, Colorado.

Gnophæla disjuncta *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One female, Jalapa, Mexico.

Anatolmis fulgens *Hy. Edw.*, Papilio, Vol. I, p. 116.—One male, Prescott, Arizona.

Triprocris basalis *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Six examples, Jalapa, Mexico.

Triprocris aversus *Hy. Edw.*, Papilio, Vol. IV, p. 13.—One male, Jalapa, Mexico.

Penthetria majuscula *Hy. Edw.*, Papilio, Vol. I, p. 80.—One male, Georgia.

Penthetria parvula *Hy. Edw.*, Papilio, Vol. I, p. 80.—One male, Indian River, Florida.

Eusemia schausii *Hy. Edw.*, Ent. Am., Vol. III, p. 90.—Three examples, Jalapa, Mexico.

BOMBYCIDÆ.

Erias obliquata *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—One male, Neuces River, Texas.

Sarrothripa columbiana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 184.—Two examples, Vancouver Island.

Nola anfracta *Hy. Edw.*, Papilio, Vol. I, p. 12.—One male, Yosemite Valley, Cal.

Hypoprepia plumbea *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—One male, one female, Minneapolis, Minn.

Clemensia irrorata *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 185.—One female, Vancouver Island.

Lithosia candida *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 185.—One female, Vancouver Island.

Crocota ostenta *Hy. Edw.*, Papilio, Vol. I, p. 12.—One male, Prescott, Arizona.

Arctia incorrupta *Hy. Edw.*, Papilio, Vol. I, p. 38.—Three males, Prescott, Arizona. One male, Oregon.

Arctia achaia var. **barda** *Hy. Edw.*, Papilio, Vol. I, p. 39.—Two males, Northern California and Dalles, Oregon.

Arctia brucei *Hy. Edw.*, Ent. Am., Vol. III, p. 183.—Male and female, Colorado.

Arctia superba *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 227.—One male, Vancouver Island.

Antarctia pteridis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 264.—One male, Vancouver Island. (=*A. puntata.*)

Antarctia punctata var. **proba** *Hy. Edw.*, Papilio, Vol. I, p. 39.—Male and female, Sierra Nevada, Cal.

Daritis thetis var. **howardi** *Hy. Edw.*, Ent. Am., Vol. II, p. 165.—One male, New Mexico.

Euprepia opulenta *Hy. Edw.*, Papilio, Vol. I, p. 38.—One male, Yukon River, Alaska.

Euprepia caja var. **utahensis** *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—Thirteen examples, Salt Lake, Utah.

Nemeophila selywnii *Hy. Edw.*, Can. Ent., Vol. XVII, p. 65.—One male, Vancouver Island.

Kodiosoma fulva *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 67.—One male, California.

Nelphe carolina *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—One male, Indian River, Florida.

Halisidota maculata var. **alni** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 129.—Two females, Mt. Shasta, Cal.

Halisidota davisii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 365.—One male, Arizona.

Halisidota ingens *Hy. Edw.*, Papilio, Vol. I, p. 39.—One female, Prescott, Arizona.

Halisidota laqueata *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—One female, Texas.

Halisidota propinqua *Hy. Edw.*, Papilio, Vol. IV, p. 76.—One male, Jalapa, Mexico.

Euhalisidota aperta *Hy. Edw.*, Papilio, Vol. IV, p. 77.—One male, Jalapa, Mexico.

Euhalisidota lurida *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Male and female, Jalapa, Mexico.

Robinsonia perfecta *Hy. Edw.*, Papilio, Vol. IV, p. 60.—Male and female, Jalapa, Mexico.

Euchætes inopinatus *Hy. Edw.*, Papilio, Vol. II, p. 13.—One male, Indian River, Florida.

Euchætes yosemite *Hy. Edw.*, Papilio, Vol. III, p. 146.—One male, two females, Yosemite Valley, Cal.

Euchætes scepsiformis *Graef*, Ent. Am., Vol. III, p. 43.—One male, Texas.

Euchætes fumidus *Hy. Edw.*, Papilio, Vol. IV, p. 61.—Male and female, Jalapa, Mexico.

Euchætes immanis *Hy. Edw.*, Papilio, Vol. IV, p. 75.—Male and female, Jalapa, Mexico.

Euchætes emendatus *Hy. Edw.*, Papilio, Vol. IV, p. 61.—Two males, one female, Jalapa, Mexico.

Orgyia badia *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 188.—Male and female, Vancouver Island. (=*O. antiqua* L.)

Orgyia gulosa *Hy. Edw.*, Papilio, Vol. I, p. 61.—Male and female, California.

Orgyia cana *Hy. Edw.*, Papilio, Vol. I, p. 62.—Two males, Havilah, Cal.

Orgyia leucostigma var. **obliviosa** *Hy. Edw.*, Ent. Am., Vol. II, p. 13.—Three males, two females, New Jersey.

Euclea elliotii *Pears*, Ent. Am., Vol II, p. 209.—One male, New York.

Limacodes beutenmuelleri *Hy. Edw.*, Can. Ent., Vol. XIX, p. 145.—One female, Enterprise, Florida.

Limacodes parallela *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—One male, Indian River, Florida.

Lagoa superba *Hy. Edw.*, Papilio, Vol. IV, p. 79.—Male and female, Jalapa, Mexico.

Psyche fragmentella *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol, VII, p. 142.—Larval cases. (Imago unknown.)

Psyche coniferella *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 142.—Larval cases. (Imago unknown.)

Oiketicus davidsonii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 142.—Larval cases. (Imago unknown.)

Pseudopsyche exigua *Hy. Edw.*, Papilio, Vol. II, p. 125.—One male, Arizona.

Nadata behrensii *Hy. Edw.*, Ent. Am., Vol. I, p. 49.—Male and female, California.

Ichthyura brucei *Hy. Edw.*, Ent. Am., Vol. I, p. 17.—One male, Colorado.

Ichthyura luculenta *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—Two males, Northern Indiana.

Ichthyura jocosa *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—One female, Indian River, Florida.

Ichthyura bifiria *Hy. Edw.*, Ent. Am., Vol. II, p. 167.—One male, Soda Springs, Cal.

Apatelodes torrefacta var. **floridana** *Hy. Edw.*, Ent. Am., Vol. II, p. 13.—One male, Indian River, Florida.

Apatelodes vivax *Hy. Edw.*, Papilio, Vol. IV, p. 77.—Male and female, Jalapa, Mexico.

Apatelodes diffidens *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—Male and female, Jalapa, Mexico.

Gluphisia wrightii *Hy. Edw.*, Ent., Am., Vol. II, p. 11.—One female, San Bernardino, Cal.

Gluphisia ridenda *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Three males, Denver, Colorado.

Gluphisia rupta *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—One male, Denver, Colorado.

Gluphisia albofascia *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Two males, Salt Lake City, Utah.

Gluphisia formosa *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Three males, Salt Lake City, Utah.

Gluphisia severa *Hy. Edw.*, Ent. Am., Vol. II, p. 167.—One female, Soda Springs, Cal.

Notodonta notaria *Hy. Edw.*, Ent. Am., Vol. I, p. 17 (=*Lophopteryx elegans* Strk.).—Four specimens, Colorado.

Lophodonta plumosa *Hy. Edw.*, Ent. Am., Vol. II, p. 14.—One male, Denver, Colorado.

Pheosia portlandia *Hy. Edw.*, Ent. Am., Vol. II, p. 168.—Male and female, Portland, Oregon.

Œdemasia perangulata *Hy. Edw.*, Papilio, Vol. II, p. 125.—One male, Colorado.

Œdemasia salicis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 121.—One male, Mt. Shasta, Cal.

Coelodasys conspecta *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 366.—One male, Napa Co., California.

Ianassa lignicolor var. **coloradensis** *Hy. Edw.*, Ent. Am., Vol. I, p. 17.—Three examples, Salt Lake City, Utah.

Ianassa laciniosa *Hy. Edw.*, Ent. Am., Vol. I, p. 129.—Male and female, Jalapa, Mexico.

Attacus cinctus *Tepper*, Bull. Brooklyn Ent. Soc., Vol. V, p. 65.—One female, Southern Arizona.

Hemileuca maia var. **lucina** *Hy. Edw.*, Ent. Am., Vol. II, p. 14.—Three males, two females, Maine.

Hyperchiria zephyria *Grote*, Tran. Kan. Acad. Sc., Vol. VIII, p. 147.—One female, near Hot Springs, Las Vegas, New Mexico.

Hyperchiria schausii *Hy. Edw.*, Papilio, Vol. IV, p. 16.—Male and female, Jalapa, Mexico.

Euleucophæus tricolor *Pack.*, Rep. Peab. Acad. Sc., April, 1872.—One male, New Mexico.

Euleucophæus sororius *Hy. Edw.*, Papilio, Vol. I, p. 100.—One female, La Paz, Lower California.

Thauma ribesii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 265.—One female, Vancouver Island.

Gloveria arizonensis *Pack.*, Papilio, Vol. IV, p. 107.—One male, Arizona.

Gloveria olivacea *Hy. Edw.*, Papilio, Vol. IV, p. 108.—Two males, two females, Jalapa, Mexico.

Clisiocampa thoracica *Stretch*, Papilio, Vol. I, p. 68.—One male, California.

Bombyx habitus *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—One male, Jalapa, Mexico.

Hepialus mcglashanii *Hy. Edw.*, Ent. Am., Vol. II, p. 14.—Three examples, Truckee, Cal.

Hepialus mathewi *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 265.—Male and female, Vancouver Island.

Hepialus rectus *Hy. Edw.*, Papilio, Vol. I, p. 35.—One female, Contra Costa Co., Cal.

Hepialus anceps *Hy. Edw.*, Papilio, Vol. I, p. 36.—Three examples, Mendocino Co., Cal.

Hepialus inutilis *Hy. Edw.*, Papilio, Vol. I, p. 36.—Male and female, Summit, Sierra Nevada, Cal.

Hepialus modestus *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 112.—One male, San Miguel, Cal.

Hepialus tacomæ *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 365.—One specimen, Tacoma, Washington.

Hepialus furcatus *Grote*, Can. Ent., Vol. XX, p. 30 (=*H. gracilis* Gr.).—One male, Colorado.

Hepialus montana *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 105.—One female, Sierra Nevada, Cal.

Phassus triangularis *Hy. Edw.*, Ent. Am., Vol. I, p. 129.—Two females, Jalapa, Mexico.

NOCTUIDÆ.

Bombycia improvisa *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 189 (as *Cymatophora improvisa*).—One male, Washington.

Bombycia tearlei *Hy. Edw.*, Ent. Am., Vol. II, p. 11 (as *Gluphisia tearlei*).—One female, Truckee, Sierra Nevada, Cal.

Raphia pallula *Hy. Edw.*, Ent. Am., Vol. II, p. 168.—Two females, Soda Springs, Siskiyou Co., Cal.

Bryophila viridata *Harv.*, Can. Ent., Vol. VIII, p. 275 (as *Jaspidia viridata*).

Diphthera spissa *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—Male and female, Jalapa, Mexico.

Diphthera spissa var. **pollux** *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—One male, Jalapa, Mexico.

Cerma olivacea *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 103.—One male, Sierra Nevada, Cal.

Dicopis damalis *Grote*, Bull. U. S. Geol. Surv., Vol. V, p. 208.—One male, Havilah, Cal.

Acronycta lupini *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 79.—One female, California.

Acronycta spini *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 78.—Male and female, Lone Mountains, Cal.

Acronycta felina *Grote*, Bull. U. S. Geol. Surv., Vol. V, p. 208.—One female, Summit, Sierra Nevada, Cal.

Acronycta americana var. **obscura** *Hy. Edw.*, Ent. Am., Vol. II, p. 169.—Four examples, Kansas City, Mo.

Copablepharon album *Harv.*, Can. Ent., Vol. VIII, p. 35.—One example, Oregon.

Agrotis havilæ *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. VI, p. 157.—Three examples, Southern California.

Agrotis milleri *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 78.—One female, Sierra Nevada, Cal.

Agrotis euroides *Grote*, Proc. Acad. Nat. Sc. Phila., 1874, p. 202.—One female, California.

Agrotis vancouverensis *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 134.—One example, Vancouver Island.

Agrotis niveivenosa *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. V, p. 206.—One female, Colorado.

Agrotis oblongistigma *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 454.—One example, Montana.

Agrotis remota *Smith*, Trans. Am. Ent. Soc., Vol. XVII, p. 48.—Two examples, Sierra Nevada, Cal.

Agrotis rena *Smith*, Trans. Am. Ent. Soc., Vol. XVII, p. 53.—Three examples, Sierra Nevada, Cal.

Agrotis nostra *Smith*, Trans. Am. Ent. Soc., Vol. XVII, p. 55.—Four examples, Sierra Nevada, Cal.

Agrotis lutulentus *Smith*, Trans. Am. Ent. Soc., Vol. XVII, p. 50.—Two males, Sierra Nevada, Cal.

Agrotis alticola *Smith*, Trans. Am. Ent. Soc., Vol. XVII, p. 51.—Three specimens, Sierra Nevada, Cal.

Agrotis pallidicollis *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 79 (as *A. cinereicollis*).—One female, California.

Agrotis brunneigera *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 80.—One female, Vancouver Island.

Mamestra comis *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 85.—One male, Vancouver Island.

Mamestra minorata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 467.—One male, Havilah, Cal.

Mamestra lepidula *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 463.—One female, Texas.

Mamestra rubrica var. **subapicalis** *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 462.—One female, Havilah, Cal.

Mamestra u-scripta *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 228.—Three examples, Sierra Nevada, Cal.

Mamestra invalida *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 225.—Three examples, Sierra Nevada, Cal.

Mamestra circumcincta *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 253.—One male, two females, Sierra Nevada, Cal.

Hadena violacea *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. VI, p. 261.—One example, Mt. Shasta District, Cal.

Hadena cinefacta *Grote*, Papilio, Vol. I, p. 77.—One female, Southern California.

Hadena unicincta *Smith*, MSS.—Male and female, Sierra Nevada, Cal.

Hadena centralis *Smith*, Proc. U. S. Nat. Mus., Vol. XIII, p. 441.—Three examples, Sierra Nevada, Cal.

Hadena rectifascia *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 108 (as *Dryobota rectifascia*).—Two examples, Sierra Nevada, Cal.

Hadena latifascia *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 108 (=*Homohadena elda* ♂ French).—Male and female, Sierra Nevada, Cal.

Hadena dunbari *Harv.*, Can. Ent., Vol. VIII, p. 52.—One female, Vancouver Island.

Pseudanarta flava var. **crocea** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 133.—Three females, Dalles, Oregon.

Perigea niveirena *Harv.*, Can. Ent., Vol. VIII, p. 53.—One female, Vancouver Island.

Perigea fasciata *Hy. Edw.*, Ent. Am., Vol. II, p. 169.—Six specimens, Colorado Desert.

Scotogramma stretchii *Hy. Edw.*, Can. Ent., Vol. XIX, p. 146.—Two examples, Colorado Desert.

Homohadena deserta *Smith*, Proc. U. S. Nat. Mus., Vol. XIII, p. 402.—One example, Colorado Desert.

Perigonica angulata *Smith*, Ent. Am., Vol. VI, p. 124.—Male and female, Sierra Nevada, Cal.

Perigrapha prima *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 119.—One female, Sierra Nevada, Cal.

Perigrapha plusiiformis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 267 (as *Stretchia plusiæformis*).—One male, Nevada.

Perigrapha inferior *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 477.—One male, Havilah, Cal.

Oncocnemis mirificalis *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. V, p. 207.—One female, Nevada.

Oncocnemis simplex *Smith*, Insect Life, Vol. I, p. 20.—One example, Ashley Valley, Utah.

Aporophyla yosemite *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 113 (as *Cucullia yosemite*).

Apamea lunata *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 110.—One example, Mt. Shasta District, Cal.

Tæniocampa pulchella *Harv.*, Can. Ent., Vol. VIII, p. 54.—One female, California.

Tæniocampa subterminata *Smith*, Proc. U. S. Nat. Mus., Vol. X, 476.—One female, New York.

Tæniocampa pectinata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 475.—One male, Havilah, Cal.

Tæniocampa curtica *Smith*, Ent. Am., Vol. VI, p. 122.—Male and female, Sierra Nevada, Cal.

Orthodes irrorata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 478.—One male, Washington.

Trichoclea edwardsii *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 460.—One male, California.

Lithophane carbonaria *Harv.*, Can. Ent., Vol. VIII, p. 55.—One female, California.

Lithophane contenta *Grote*, Can. Ent., Vol. XII, p. 216.—One example, California.

Lithophane oregonensis *Harv.*, Can. Ent., Vol. VIII, p. 55.—One female, Oregon.

Lithophane washingtonia *Grote*, Papilio, Vol. III, p. 74.—One male, Soda Springs, Mt. Shasta, Cal.

Lithophane gausapata *Grote*, Papilio, Vol. III, p. 77.—One example, Soda Springs, Mt. Shasta, Cal.

Cleophane eulepis *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 86.—One female, Oregon.

Deva morigera *Hy. Edw.*, Ent. Am., Vol. II, p. 169.—One female, Colorado.

Deva palligera *Grote*, Papilio, Vol. I, p. 35.—One specimen, Sierra Nevada, Cal.

Plusia celsa *Hy. Edw.*, Papilio, Vol. I, p. 101.—One female, Mt. Hood, Oregon.

Plusia californica var. **russea** *Hy. Edw.*, Ent. Am., Vol. II, p. 170.—Two females, Colorado and California.

Plusia vaccinii *Hy. Edw.*, Ent. Am., Vol. II, p. 170.—One female, Mt. Washington, New Hampshire.

Plusia howardi *Hy. Edw.*, Proc. Cal. Acad. Sc., March 5, 1877.—One example, Prescott, Arizona.

Plusia scapularis *Hy. Edw.*, Papilio, Vol. II, p. 127.—One example, Washington.

Pleroma obliquata *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 114.—One female, Sierra Nevada, Cal.

Anarta kelloggii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 133. One female, Sierra Nevada, Cal.

Triocnemis saporis *Grote*, Papilio, Vol. I, p. 77.—One example, Southern California.

Euros proprius *Hy. Edw.*, Papilio, Vol. I, p. 19.—One female, Mt. Shasta District, Cal.

Melicleptria exalta *Hy. Edw.*, Papilio, Vol. IV, p. 124.—One male, San Antonio, Texas.

Melicleptria fasciata *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 134.—Two examples, Placer Co., California.

Melicleptria elaborata *Hy. Edw.*, Papilio, Vol. I, p. 21.—One example, Colorado.

Melicleptria belladonna *Hy Edw.*, Papilio, Vol. I, p. 20.—One female, Southern Utah.

Melicleptria oregonica *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 135.—Three examples, Sierra Nevada, Cal. One example, Colorado.

Lygranthœcia walsinghami *Hy. Edw.*, Papilio, Vol. I, p. 20.—Male and female, Klamath Lake, Oregon.

Adonisea pulchripennis var. **languida** *Hy. Edw.*, Papilio, Vol. I, p. 20.—One male, Havilah, Cal.

Xanthothrix ranunculi *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—Five examples, Havilah, Kern Co., Cal.

Xanthothrix neumœgeni *Hy. Edw.*, Papilio, Vol. I, p. 101.—Two specimens, Santa Barbara Co., Cal.

Tarache arizonæ *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878 (as *Thalpochares arizonæ*).—Two examples, Prescott, Arizona.

Tarache sedata *Hy. Edw.*, Papilio, Vol. I, p. 23.—One specimen, Prescott, Arizona.

Annaphila superba *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 139.—Two specimens, Napa and Marin Co., Cal.

Annaphila domina *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 138.—One female, San Mateo Co., Cal.

Annaphila aurantiaca *Hy. Edw.*, Papilio, Vol. I, p. 23.—One example, Geysers, Cal.

Annaphila germana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 138.—One female, Napa Co., Cal.

Annaphila salicis *Hy. Edw.*, Papilio, Vol. I, p. 23.—One example, Oregon.

Annaphila pustulata *Hy. Edw.*, Papilio, Vol. I, p. 23.—One female, Prescott, Arizona.

Annaphila lithosina *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 137.—One example, Havilah, Cal.

Tripudia opipara *Hy. Edw.*, Papilio, Vol. I, p. 117 (as *Oribates opiparus*).—One male, Texas.

Tripudia limbata *Hy. Edw.*, Papilio, Vol. I, p. 22 (as *Oribates limbatus*).—Two examples, Mazatlan, Mexico.

Gyros muirii *Hy. Edw.*, Papilio, Vol. I, p. 22 (as *Oribates muirii*).—Two specimens, Havilah, Cal.

Axenus arvalis var. **amplus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 136.—Two examples, Klamath Lake, Oregon.

Axenus arvalis var. **ochraceus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 136.—One female, San Diego, Cal.

Fruva acerba *Hy. Edw.*, Papilio, Vol. I, p. 24.—Two examples, Sonoma Co., Cal.

Fruva accepta *Hy. Edw.*, Papilio, Vol. I, p. 24.—Male and female, Tallahassee, Florida.

Fruva modesta *Hy. Edw.*, Papilio, Vol. IV, p. 124.—Two examples, California.

Fruva deleta *Hy. Edw.*, Papilio, Vol. IV, p. 124.—One male, Virginia City, Nevada.

Litocala sexsignata var. **deserta** *Hy. Edw.*, Papilio, Vol. I, p. 25.—Two males, two females, Colorado and Arizona.

Syneda sesposita *Hy. Edw.*, Papilio, Vol. I, p. 25.—One male, Southern Colorado.

Syneda faceta *Hy. Edw.*, Papilio, Vol. I, p. 119.—One male, Indian River, Florida.

Syneda mirifica *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—Two examples, Virginia City, Nevada.

Syneda hastingsii *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One example, Dalles, Oregon.

Syneda hastingsii var. **perpallida** *Hy. Edw.*, Papilio, Vol. I, p. 25.—One female, Summit, Sierra Nevada, Cal.

Syneda saxea *Hy. Edw.* (=*S. allenii*), Papilio, Vol. I, p. 26.—One specimen, Colorado.

Cirrhobolina tetrica *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One male, Sacramento, Cal.

Synedoida inepta *Hy. Edw.*, Papilio, Vol. I, p. 27.—One female, Southern Colorado.

Synedoida biformata *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—Two males, Havilah, Kern Co., Cal.

Synedoida scrupulosa *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One male, two females, Havilah, Kern Co., Cal.

Synedoida morbosa *Hy. Edw.*, Papilio, Vol. I, p. 27.—Male and female, Southern Colorado. One male, Prescott, Arizona.

Synedoida sabulosa *Hy. Edw.*, Papilio, Vol. I, p. 26.—One female, Southern Colorado.

Catocala amica var. **nerissa** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 61.—One specimen, Southwestern Texas.

Catocala dulciola *Grote*, Papilio, Vol. I, p. 5.—One female, Dayton, Ohio.

Catocala badia var. **phœbe** *Hy. Edw.*, Papilio, Vol. IV, p. 125.—Two examples, New Hampshire.

Catocala neogama var. **snowiana** *Grote*, New Check List Noct., p. 41, 1876.—One female, Kansas.

Catocala andromache *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One male, San Bernardino, Cal.

Catocala fratercula var. **jacquenetta** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 60.—One female, Albany, New York.

Catocala fratercula var. **hero** *Hy. Edw.*, Papilio, Vol. IV, p. 125.—Two examples, Florida.

Catocala cordelia *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 59 (=*C. amasia*).—One male, Tallahassee, Florida.

Catocala ultronia var. **celia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 58.—Four examples, Indian River, Florida.

Catocala ultronia var. **mopsa** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—Two examples, Florida.

Catocala ultronia var. **adriana** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—One example, New York.

Catocala verrillana var. **violenta** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 58 (as *C. violenta*).—One example, Southern Colorado.

Catocala stretchii var. **hippolyta** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 211 (as *C. hippolyta*).—One male, San Mateo Co., Cal.

Catocala cassandra *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 214.—One female, Guadalajara, Mexico.

Catocala stretchii var. **portia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. II, p. 94 (as *C. portia*).—One male, Lake Tahoe, Cal.

Catocala jessica *Hy. Edw.*, Proc. Cal. Acad. Sc., January 15, 1877 (=*C. stretchii* Behr.).—Two examples, Havilah, Kern Co., Cal.

Catocala mariana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 210.—One male, Vancouver Island.

Catocala mariana var. **francisca** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—Two males, Humboldt Co., Cal.

Catocala hermia *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. II, p. 93.—One female, Colorado.

Catocala irene var. **virgilia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—Three males, one female, Mendocino Co., Cal.

Catocala irene var. **valeria** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—One female, Arizona.

Catocala irene var. **volumnia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—One example, Mendocino Co., Cal.

Catocala elda *Behrens*, Can. Ent., Vol. XIX, p. 199.—One female, Portland, Oregon.

Catocala rosalinda *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 55.—One example, Albany, N. Y.

Catocala miranda *Hy. Edw.*, Papilio, Vol. I, p. 118.—One male, Washington, D. C.

Catocala cara var. **silvia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.

Catocala augusta *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 184.—One female, San Diego, Cal.

Catocala luciana *Hy. Edw.*, Proc Cal. Acad. Sc., Vol. VI, p. 211.—Three examples, Colorado.

Catocala californica var. **cleopatra** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 209 (as *C. cleopatra*).—One male, Contra Costa Co., Cal.

Catocala californica var. **perdita** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 211 (as *C. perdita*).—Two examples, San Mateo Co., Cal.

Catocala relicta var. **phrynia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 54.—One male, Albany, N. Y.

Catocala relicta var. **bianca** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 54.—Male and female, Albany, N. Y.

Catocala lacrymosa var. **emilia** *Hy. Edw.*, Papilio, Vol. I, p. 117.—One female, Long Island, N. Y.

Catocala angusii *Gr.*, Can. Ent., Vol. VIII, p. 229.—One male, West Farms, New York City.

Catocala residua *Gr.*, Proc. Boston Soc. Nat. Hist., Vol. XVI, p. 242.—Male and female, West Farms, New York City.

Antiblemma guttula *Hy. Edw.*, Papilio, Vol. II, p. 129.—One example, Georgia.

Phoberia indiscreta *Hy. Edw.*, Ent. Am. Vol. II, p. 170.—One female, Havilah, Cal.

Pleonectyptera obliqualis *Hy. Edw.*, Ent. Am., Vol. II, p. 171.—One example, Texas.

Homoptera rubi *Hy. Edw.*, Papilio, Vol. I, p. 28.—Male and female, Havilah, Cal.

GEOMETRIDÆ.

Azelina australata *Hulst*, Ent. Am., Vol. I, p. 205.—One male, Indian River, Florida.

Tetracis mellitularia *Hulst*, Ent. Am., Vol. I, p. 202.—Two females, Sierra Nevada, Cal.

Anaplodes festaria *Hulst*, Ent. Am., Vol. II, p. 121.—One male, San Francisco, Cal.

Geometra illustraria *Hulst*, Ent. Am., Vol. II, p. 121.—One female, California.

Eucrostis saltusaria *Hulst*, Ent. Am., Vol. II, p. 122.—One female, Indian River, Florida.

Eucrostis jaspidiaria *Hulst*, Ent. Am., Vol. II, p. 122.—One male, Indian River, Florida.

Acidalia 5-lineata var. **fuscata** *Hulst*, Ent. Am., Vol. II, p. 187.—One female, Summit, Sierra Co., Cal.

Marmopteryx annellata *Hulst*, Ent. Am., Vol. II, p. 191.—One female, Havilah, Cal.

Marmopteryx morrisata *Hulst*, Ent. Am., Vol. II, p. 190.—One female, Nevada.

Semiothisa umbriferata *Hulst*, Ent. Am., Vol. II, p. 189.—One male, California.

Halia tripunctaria *Pack.*, Proc. Boston Soc. Nat. Hist., Vol. XVI, p. 26.—One female, California.

Tephrosia carnearia *Hulst*, Ent. Am., Vol. III, p. 216.—Male and female, Havilah, Cal.

Tephrosia celataria *Hulst*, Ent. Am., Vol. III, p. 216.—One male, Havilah, Cal.

Tephrosia fautaria *Hulst*, Ent. Am., Vol. III, p. 216.—One female, California.

Boarmia furfuraria *Hulst*, Ent. Am., Vol. III, p. 214.—One male, California.

Boarmia plumogeraria *Hulst*, Ent. Am., Vol. III, p. 216.—One male, California.

Scotosia meadii *Pack.*, Sixth Rep. Peab. Acad. Sc., p. 41 (as *Scotosia meadii*).—One female, Colorado.

Lobophora montanata *Pack.*, Sixth Rep. Peab. Acad. Sc., p. 40.—One example, Colorado.

Cidaria nocticolata *Hulst*, Bull. Brooklyn Ent. Soc., Vol. IV, p. 26.—One female, Colorado.

Cidaria opacaria *Hulst*, Bull. Brooklyn Ent. Soc., Vol. IV, p. 27.—One male, Colorado.

Phrygionis auriferaria *Hulst*, Ent. Am., Vol. II, p. 188.—One example, Florida.

Hemerophila packardaria *Hulst*, Ent. Am., Vol. III, p. 217.—One male, California.

Aspilates behrensaria *Hulst*, Ent. Am., Vol. II, p. 210.—One male, Knight Valley, Cal.

Eois ferrugata var. **russata** *Hulst*, Ent. Am., Vol. II, p. 187.—One male, New York.

Cleoria punctomacularia *Hulst*, Ent. Am., Vol. III, p. 214.—One male, Vancouver Island.

Triphosa dubitata var. **pustularia** *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One female, Soda Springs, Cal.

Triphosa badiaria *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One female, Shasta Co., Cal.

Caterva elegantaria *Hy. Edw.*, Papilio, Vol. I, p. 121.—Male and female, Prescott, Arizona.

Gorytodes personaria *Hy. Edw.*, Papilio, Vol. I, p. 120.—One male, Sierra Nevada, Cal.

PYRALIDÆ.

Prorasea lepidalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 146.—One male, Colorado.

Prorasea brunneogrisea *Hy. Edw.*, Ent. Am., Vol. II, p. 171.—One male, Prescott, Arizona.

Aglossa electalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 146.—One example, Arizona.

Chalcœla gemmalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 148.—One example, Sierra Nevada, Cal.

Emprepes magnalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 147.—One female, Arizona.

Botys uxorculalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, Sierra Nevada, Cal.

Botys bellulalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 149.—One example, Texas.

Botys psychicalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 149.—One example, Texas.

Botys roseopennalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 148.—One example, Arizona.

Botys pergilvalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 151.—One female, Arizona.

Botys fumoferalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, Sierra Nevada, Cal.

Botys monulalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, Sierra Nevada, Cal.

Botys thallophilalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, California.

Botys scurralis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 155.—One female, Arizona.

Botys festalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One female, Prescott, Arizona.

Botys lulualis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 150.—One female, Soda Springs, Cal.

Botys succandidalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, Texas.

Botys octosignalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, Calfornia.

Botys levalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 152.—One specimen, Florida.

Botys penitalis *Grote*, Can. Ent., Vol. VIII, p. 98.—One female, Kansas.

Botys unifascialis *Pack.*, Ann. Lyc. Nat. Hist., N. Y., Vol. X, p. 261.—One example, California.

Eurycreon aureolalus *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 156.—One female, Colorado.

Orobena reluctalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 156.—One example, Arizona.

Glyphodes alitalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 157.—One example, Indian River, Florida.

Metrea ostreonalis *Grote*, Papilio, Vol. II, p. 73.—One female, Connecticut.

Metrea argentalis *Hy. Edw.*, Papilio, Vol. IV, p. 19.—One example, Jalapa, Mexico.

Hydrocampa gyralis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 159.—One example, Georgia.

Tetralophus atrifascialis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 73.—One example, Indian River, Florida.

Nephopteryx lallatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 161.—One example, Florida.

Nephopteryx bifasciella *Hulst*, Ent. Am., Vol. III, p. 132.—One example, Arizona.

Megaphycis edwardsialis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 163.—One female, Nevada.

Acrobasis alatella *Hulst*, Ent. Am., Vol. III, p. 135.—One example, Napa Co., Cal.

Acrobasis hystriculella *Hulst*, Ent. Am., Vol. III, p. 135.—One female, Texas.

Spermatophthora montinatatella *Hulst*, Ent. Am., Vol. III, p. 134.—One example, Sierra Nevada, Cal.

Mylois zelatella *Hulst*, Ent. Am., Vol. III, p. 136.—One example, New York.

Mylois aliculella *Hulst*, Ent. Am., Vol. III, p. 135.—Male and female, Arizona.

Stenoptycha pallulella *Hulst*, Ent. Am., Vol. III, p. 137.—One example, North Carolina.

Ephestia opalescella *Hulst*, Ent. Am., Vol. III, p. 138.—One example, California.

Anerastia electella *Hulst*, Ent. Am., Vol. III, p. 137.—One male, Texas.

Crambus biothanatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 166.—One example, California.

Crambus comptulatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 167.—One example, Vancouver Island.

PTEROPHORIDÆ.

Lioptilis grandis *Fish*, Can. Ent., Vol. XIII, p. 141.—One example, California.

Œdemataphorus gratiosa *Fish*, Can. Ent., Vol. XIII, p. 73.—One male, Sierra Nevada, Cal.

Œdemataphorus lugubris *Fish*, Can. Ent., Vol. XIII, p. 140.—One female, California.

Platyptilis edwardsii *Fish*, Can. Ent., Vol. XIII, p. 72.—Male and female, Boston, Mass.

Article XIV.—THE GEOGRAPHICAL DISTRIBUTION OF NORTH AMERICAN MAMMALS.[1]

By JOEL ASAPH ALLEN.

(*With Four Maps, forming Plates V–VIII.*)

INFLUENCES DETERMINING THE GEOGRAPHICAL DISTRIBUTION OF LIFE.

It has long been recognized that the influences determining the distribution of life over the earth's surface are climate and the interrelation of the principal land areas. It is questionable which of the two, all things considered, has been the more important factor in bringing about the present distribution of life, since the climate of any given area depends largely upon the relative distribution of land and water, and is further greatly modified by the topography of the principal land areas, the presence or absence of lofty mountain chains greatly modifying the climate of an entire continent.

CLIMATE.—Of strictly climatic influences, temperature is by far the most important, although moisture plays an influential part. Where a low temperature prevails life, both animal and vegetable, is represented by comparatively few forms; under a high temperature it is characterized by great diversity and luxuriance. Within the Arctic Circle the species of both plants and animals are not only few but they are widely distributed, being for the most part everywhere the same. Under the tropics they are a hundred fold more numerous and of comparatively restricted distribution, the general facies, as regards both the fauna and the flora, changing within short distances, with few elements in common when widely separated areas are compared.

The influence of temperature is perhaps most strikingly displayed in the distribution of life upon the slopes of a high mountain, especially if situated near the tropics. While its base may be clothed with palms and luxuriant tropical vegetation its sum-

[1] Read before the New York Academy of Sciences, January 26, 1891. In revising for publication some new matter has been added, chiefly in the last third of the paper and in the footnotes.

mit may be snow-capped and barren, or scantily covered with only a small variety of hardy alpine shrubs and plants. The animal life becomes likewise correspondingly changed, tropical forms of mammals, birds and insects of the lower slopes gradually giving place to such as are characteristic of arctic latitudes.[1]

The influence of moisture is most strikingly shown in the distribution of forest trees, where on the same continent, under corresponding parallels of latitude, and at nearly the same elevation, the country may be either heavily or only sparsely wooded, or even wholly devoid of a forest growth, in accordance with the abundance or scarcity of the rain-fall. We may thus have, on the same continent, immense areas of forest alternating with vast stretches of open prairies and plains, or even almost verdureless deserts. The effect of humidity upon plant life is thus obvious; but it is equally potent, though less evident, upon animal life. Many animals—mammals and birds as well as insects—are so fitted for a forest life, as regards both food and shelter, that their very existence depends upon such surroundings. Others are equally specially adapted for life on the open plains, or even in arid deserts. Thus moisture alone may determine the character of life over extensive regions, regardless of temperature, which under ordinary conditions is the ascendant controlling influence.

INTERRELATION OF LAND AREAS.—The relation of the principal land areas to each other, in respect to continuity on the one hand and isolation on the other, is coëval and perhaps more than coördinate with climate in its influence upon the distribution of life, as it is also in the evolution of life. Palæontology teaches us that the present characteristics of the faunas and floras of the principal land areas are the results of a long period of evolution, during which there have been no very sudden transitions, but, in general, a gradual development from ancestral forms having about the same geographical distribution as their descendents. While some of the continents have unquestionably derived part of their life from neighboring continents, and islands from the mainland to which they are contiguous, these

[1] An excellent illustration of the influence of temperature upon the distribution of life on mountain slopes is afforded by Dr. C. Hart Merriam's thorough survey of the San Francisco Mountain region in Arizona, the life-zones of which he has defined and illustrated in detail. (See N. Am. Fauna, No. 3, Sept., 1890, pp. 5-20, pll. 1, 2, and maps 1-4.)

migrations are in the main of great antiquity, dating back at least nearly to the Miocene. At that early time, and also previously, there was not only a greater uniformity of climate, but a more uniform distribution of life. With the coming in of the Glacial Period a great change was wrought in respect to both, and the former equilibrium in neither has been restored. While it would lead me too far from the subject especially in hand to discuss at any length the probable geographical origin of the leading types of even the present mammalian life of North America, it seems well to recall, in the present connection, certain facts of general import. In the first place, the so-called Old World is admittedly the most advanced and the most specialized of the several continents, as regards both its physical features and its biology; and that probably many of its present leading types of mammalian life are of American origin; that North America is behind Eurasia in development, and South America behind North America; and that in reality Australia is the old continent in the sense of being behind all the others in its development, and thus the lowest, the least specialized, the most primitive.

In regard to the present distribution of the mammals of North America and their faunal relationship to the mammalia of the rest of the world, it is important to recall the present close proximity of North America at the northward to the northern portion of the Old World. Alaska is separated from Siberia by a shallow strait of less than forty miles in width, while in Tertiary times it is supposed they may have been united. Three-fourths of the land area is not only situated north of the equator, but is mainly massed about the northern pole, the only extensive stretch of sea being the few hundred miles between Iceland and Norway. If now we bear in mind the close similarity in climate and general physical conditions of the northern half of the northern hemisphere, its comparatively low temperature and meagre fauna and flora as compared with the tropics, and that continuity of land area tends to uniformity of life, and divergence and isolation tend to diversity of life, and increase of temperature to abundance and variety, the generalizations about to follow respecting the life regions of North America will, I trust, be recognized as resting on a sound basis.

Importance of Mammals as a Basis for the Classification of Life Areas.

First, however, a word in reference to the class Mammalia as a basis for the distribution of the earth's surface into ontological divisions. On this point I cannot do better than to summarize the argument made by Mr. A. R. Wallace in his great work on 'The Geographical Distribution of Animals,' simply premising that his presentation of the case has my hearty approval.

The mammalia, he affirms, are pre-eminently of the greatest importance in determining zoölogical regions. Their dispersal is less dependent on fortuitous circumstances than that of the representatives of other classes; from their high organization they are less dependent upon other groups of animals, and have so much power of adaptation that they are able to exist in one form or another over the whole globe, as is certainly not the case with two of the lower classes of vertebrates, the reptilia and amphibia. Their distribution and dispersal are dependent on the distribution of the land areas, and are modified by such physical conditions as mountain barriers, areas of forest, and grassy or desert plateaus. Furthermore, their geological history, as well as their geographical range, is better known than that of most other classes, and there is also a greater unanimity of opinion respecting their natural affinities and the limitation of families and genera. "We should therefore," says Mr. Wallace, "construct our typical or standard Zoölogical Regions in the first place, from a consideration of the distribution of mammalia, only bringing to our aid the distribution of other groups to determine doubtful points. Regions so established will be most closely in accordance with these long-enduring features of physical geography, on which the distribution of all forms of life fundamentally depend; and all discrepancies in the distribution of other classes of animals must be capable of being explained, either by their exceptional means of dispersion or by special conditions affecting their perpetuation and increase in each locality. If these considerations are well founded, the objections of those who study insects or molluscs, for example,—that our regions are not true for their departments of nature—cannot be maintained. For they will find, that a careful consideration of the exceptional means of dispersal and conditions of existence of each group, will explain most of the divergences from the normal distribution of higher animals."[1]

While the divisions of North America, as set forth in the present paper, are presented from the standpoint of mammals, it may be premised that many of them were first outlined on the basis of the distribution of birds, and that they have been found equally applicable to reptiles and bratracians, and also in a measure to insects and plants.[2]

Systematic Classification of Life Areas.

In zoö-geography it is customary to recognize faunal areas belonging to several different categories, as regards their grade and extent, just as in zoölogy we divide animals into classes, orders, families, genera, and species. Unfortunately, however, the terms employed for their designation have not been used with the same precision as in zoölogical terminology. Identical terms have sometimes been used in diametrically opposite senses, in accordance with each writer's individual preferences, regardless of their prior use in a different sense by other authors. In view of this unfortunate state of affairs I attempted, in a paper on the distribution of North American birds, published in 1871,[3] to devise a system of terms that, while appropriate, should at the same time be in as close conformity as possible with current usage. Previously the terms *zone*, *realm*, *region*, *kingdom*, *province*, and even *fauna*, had been used more or less interchangeably for even the primary subdivisions, while some of these terms were also frequently employed in a narrower and more special sense. The scheme then proposed is as follows :

For divisions of the first rank	*Realm.*
" " second "	*Region.*
" " third "	*Province.*
" " fourth "	*Subprovince* or *District.*
" " fifth "	*Fauna*, *Flora.*

[1] Geogr. Dist. Anim., Vol. I, pp. 56–58.

[2] Since this was written Dr. C. Hart Merriam, in his admirable presidential address, entitled 'The Geographic Distribution of Life in North America with Special Reference to the Mammalia,' read before the Biological Society of Washington, February 6, 1892 (Proc. Biol. Soc. Wash., Vol. VII, April, 1892, pp. 1–64), has given a 'Historical Synopsis of Faunal and Floral Divisions Proposed for North America' (l. c., pp. 6–21) which may be profitably consulted in the present connection.

[3] On the Mammals and Winter Birds of East Florida, with....a Sketch of the Bird Faunæ of Eastern North America. Bull. Mus. Comp. Zoöl., Vol. II, No. 3, April, 1871.

Their grade and order of sequence may be indicated by a comparison with the leading groups in zoölogy: thus *realm* would correspond in rank with *class; region* with *order; province* with *family; district* with *genus;* and *fauna* (or *flora*, as the case may be) with *species*. It sometimes becomes convenient, as we shall see later, to recognize other divisions intermediate to those above named—as in zoölogy we have suborder, subfamily, subgenus, etc., so we may have here subregions, subprovinces, and even subfaunæ. There may also be a subdivision of a continental or other large area into zones.

Temperate North America forms a *region* of the *North Temperate Realm*, and includes two *subregions*, one of which is divisible into two *provinces;* each *province* is separable into two *subprovinces* and these again into several lesser well-marked areas termed *faunæ*, as will be presently shown in detail. Realms are sometimes characterized by the presence of certain orders, commonly by the presence of certain families, which give to the region a particular impress, and by the absence of others which in a similar way characterize other realms. Regions are usually characterized by the prevalence over them of certain genera, or even by entire families; provinces by the presence or absence of prominent generic types. Faunæ, on the other hand, are seldom characterized by the presence or absence of particular genera or species but by the association, through the overlapping of their habitats, of a number of genera and species not elsewhere found together.

The transition between faunæ, between provinces, or between adjoining divisions of any grade is rarely abrupt; it is impossible to draw a hard-and-fast line between any of them; yet in a general way they may be limited with considerable definiteness. They depend upon climatic conditions, which, in a measure, are determined or modified by features of topography. They are of course limited and determined by the same conditions that govern the distribution of species. Hence we can seldom bound our faunal areas by geographical meridians or by parallels of latitude, and very rarely are they found to agree with any political boundaries; they do, however, closely coincide with certain isothermal lines, which are generally those of the season of reproduction, or, in the northern hemisphere, those for the months of May, June and July. As temperature is influenced by altitude as well as by latitude, elevated plateaus and mountain ranges deflect the isotherms in the northern hemisphere far to the southward of their position over the contiguous low country, and furnish congenial habitats for northern forms of life under comparatively low latitudes. Thus in eastern North America the Appalachian Highlands carry the fauna of northern New England southward along the higher parts of the Alleghanies as far as northern Georgia. In the Rocky Mountains boreal types extend far down into Mexico, and along the Cascade and Sierra Nevada chain to southern California, with insular patches of northern life on the summits of detached peaks and ranges throughout the Plateau and Great Basin regions of the West. There is thus an interdigitation of the northern and southern life areas throughout the middle and southern portions of the North American continent.

The life of the globe is everywhere closely linked together. While the relationship at the northward is obviously intimate, and while in general the life of the intertropical zone is very different from that of the arctic or even of the temperate zones, and that of tropical America is very unlike that of tropical Africa or India, yet certain types are common to the whole. For example, the Cat family is represented throughout all countries except Australia, but there is a great difference between the Cats of the colder zones and those of the equatorial regions; yet the genus *Felis*, taken in a broad sense, is almost cosmopolitan. The Dog family, embracing the Wolves and Foxes, has an even wider distribution. The family Mustelidæ, embracing the Otters, Badgers, Skunks, Sables, Weasels, Minks and Martens, is more restricted, some of its leading forms, however, having a much wider and a very different distribution from others. Thus the Otters (subfamily Lutrinæ) are nearly cosmopolitan, while the true fur-bearing animals (subfamily Mustelinæ) are distinctively northern and circumpolar; the Skunks (subfamily Mephitinæ), on the other hand, are exclusively American, and range over the temperate and tropical portions of both continents. The order Insectivora has no representatives in either South America or Australia; the Hedghogs, forming a family of the order, are exclusively an Old

World type; the Shrews, forming a second family, have a circumpolar distribution, the genus *Sorex* ranging on both continents from the Arctic regions to within the tropics. The Moles, forming a third family of this order, are confined to the north temperate latitudes, and are represented by different and peculiar genera in Europe, Asia, Africa and North America, and in the latter continent are confined mainly to the United States east of the Great Plains. Among Rodentia the genus *Sciurus*, consisting of the true or arboreal Squirrels, the genus *Sciuropterus*, or the Flying Squirrels, and the genus *Lepus*, embracing the Hares and Rabbits, are other examples of wide-ranging genera, the arboreal Squirrels and the Hares occurring everywhere except in Australia, although both are sparingly represented in America south of the Isthmus of Panama, beyond which the Flying Squirrels wholly cease to exist. But the species are generally of local distribution, and to some extent different styles of Squirrels and Hares characterize different areas of the common habitat of the group. Northern North America has several genera of Field Mice which are also common to the northern parts of the Old World, but the great bulk of our native Rats and Mice belong to genera peculiar to America. Also our Jumping Mouse, the numerous species of Kangaroo Rats and Pocket Mice, all the Pocket Gophers and the Prairie Dogs are distinctively North American.

These few illustrations, from the many that might be given, will serve to indicate, in a general way, the basis on which the life areas of North America, and of the world at large, are founded.

Primary Life Regions.

Seven primary life regions, speaking of the world as a whole, may be recognized, as follows:

1. An *Arctic Realm*, occupying the region north of the isotherm of 32° F., its southern boundary conforming very closely to the northern limit of trees. Its more characteristic terrestrial forms of both animal and vegetable life range nearly throughout its extent. It is thus so homogeneous in its ontological characters as not to require subdivision into regions and provinces, though embracing several slightly-marked areas of the rank of faunæ.

2. A *North Temperate Realm*, embracing the whole of that portion of the northern hemisphere embraced between the annual isotherms of 32° and 70° F.

3. An *American Tropical Realm*, consisting, as the name implies, of tropical America.

4. An *Indo-African Realm*, consisting of Africa (except the northern border), and tropical Asia and its outlying tropical islands.

5. A *South American Temperate Realm*, embracing extra-tropical South America.

6. An *Australian Realm*, including not only the continent of Australia but New Guinea, New Zealand, and the various groups of islands to the northward and eastward.

7. A *Lemurian Realm*, consisting of Madagascar.

An eighth or *Antarctic Realm* is also often recognized. It is almost wholly oceanic, and its fauna hence consists almost exclusively of marine or pelagic species, and is of course the Antarctic counterpart of the Arctic Realm, though perhaps less well characterized.

North Temperate Realm.

The North Temperate Realm is divisible primarily into two Regions, namely, (1) a *North American Region*, occupying the whole of North America from the beginning of forest vegetation southward to about the northern limit of palms, or the area between the annual isotherms of 32° and 70° F.; and (2) an *Eurasiatic Region*, consisting of the corresponding portion of the Old World.

This region, and the Old World in general, lying outside of the special scope of the present paper, we will now pass to a detailed consideration of the mammalian fauna of North America, and the principal faunal subdivisions of the North American Continent, their distinctive characteristics, their relation to each other, and to the Eurasiatic Region.

Attention has already been directed to the intimate geographic relation of northern North America to northern Eurasia, and the

Genera of Land Mammals of the North Temperate Realm.

[NOTE.—The names of circumpolar genera are in *italics*; those of genera peculiar respectively to the North American and Eurasiatic Regions are in SMALL CAPS.]

NORTH AMERICAN REGION.			EURASIATIC REGION.		
	Subregions.			Subregions.	
Genera.	Cold Temp.	Warm Temp.	Genera.	Cold Temp.	Warm Temp.
Didelphys	—	+	Sus	+	+
Dicotyles	—	+	CAMELUS	—	+
Cariacus	—	+	MOSCHUS	+	+
Cervus	+	—	*Cervus*	+	+
Alces	+	—	*Alces*	+	—
Rangifer	+	—	*Rangifer*	+	—
ANTILOCAPRA	—	+	DAMA	—	+
Bison	+	+	CAPREOLUS	+	+
Ovis	+	—	ELAPHODUS	—	+
MAZAMA	+	—	HYDROPOTES	—	+
Arctomys	+	+	*Bison*	+	—
CYNOMYS	—	+	POËPHAGUS	—	+
Tamias	+	+	ADDAX	—	+
Spermophilus	+	+	Oryx	—	+
Sciurus	+	+	Gazella	—	+
Sciuropterus	+	+	SAIGA	—	+
APLODONTIA	+	—	PANTHOLOPS	—	+
Castor	+	+	RUPICAPRA	+	—
FIBER	+	+	BUDORCAS	—	+?
Cuniculus	+	—	Nemorhœdus	+	+
Myodes	+	—	Capra	+	+
SYNAPTOMYS	+	+	*Ovis*	+	+
Evotomys	+	—	Equus	—	+
Arvicola	+	+	*Castor*	+	—
PHENACOMYS	+	—	*Sciurus*	+	+
ONYCHOMYS	—	+	*Sciuropterus*	+	+
Sitomys	+	+	Pteromys	—	+
Reithrodontomys	—	+	*Tamias*	+	—
Sigmodon	—	+	*Spermophilus*	+	—
Oryzomys	—	+	*Arctomys*	+	—
Neotoma	—	+	MYOXUS	—	+
THOMOMYS	—	+	ELIOMYS	+	+
GEOMYS	—	+	MUSCARDINUS	—	+
PEROGNATHUS	—	+	Mus	+	+
MICRODIPODOPS	—	+	Gerbillus	+	+
DIPODOMYS	—	+	CRICETUS	+	+
PERODIPUS	—	+	Meriones	—	+
ZAPUS	+	+	SMINTHUS	+	—
ERETHIZON	+	—	*Arvicola*	+	+
Lagomys	+	—	*Evotomys*	+	—
Lepus	+	+	*Cuniculus*	+	—
ANTROZOUS	—	+	*Myodes*	+	—
Vesperugo	+	+	ELLOBIUS	+	—
NYCTICEJUS	—	+	SIPHNEUS	+	—

North American Region.

Genera.	Subregions. Cold Temp.	Subregions. Warm Temp.
Atalapha	+	+
Plecotus	—	+
Vespertilio	+	+
EUDERMA	—	+
Molossus	—	+
Nyctinomus	—	+
Otopterus	—	+
Sorex	+	+
NOTIOSOREX	?	+
BLARINA	—	+
SCALOPS	—	+
SCAPANUS	—	+
CONDYLURA	+	+
Urotrichus	—	+
Ursus	+	+
Procyon	+	+
BASSARISCUS	—	+
Lutra	+	+
MEPHITIS	+	+
Conepatus	—	+
SPILOGALE	—	+
TAXIDEA	+	+
Gulo	+	—
Lutreola	+	+
Putorius	+	+
Mustela	+	—
UROCYON	—	+
Vulpes	+	+
Canis	+	+
Lynx	+	+
Felis	—	+

Eurasiatic Region.

Genera.	Subregions. Cold Temp.	Subregions. Warm Temp.
SPALAX	+	—
Rhizomys	—	+
Dipus	—	+
Alactaga	+	+
PLATYCERCOMYS	+	—
Hystrix	—	+
Lagomys	+	—
Lepus	+	+
Rhinolophus	—	+
TRIÆNOPS	—	+
SYNOTUS	—	+
Plecotus	—	+
Vesperugo	+	+
Harpiocephalus	—	+
Vespertilio	+	+
Miniopterus	—	+
RHINOPOMA	—	+
Nyctinomus	—	+
Erinaceus	+	+
Sorex	+	+
CROSSOPUS	+	—
Crocidura	—	+
ANUSOREX	—	+
DIPLOMESODON	—	+
CHIMARROGALE	—	+
NECTOGALE	—	+
MYOGALE	—	+
Urotrichus	—	+
UROPSILUS	—	+
SCAPTONYX	—	+
TALPA	—	+
SCAPTOCHIRUS	—	+
Ursus	+	+
ÆLUROPUS	—	+
ÆLURUS	—	+
MELES	+	+
MELLIVORA	—	+
ARCTONYX	—	+
Lutra	+	+
Gulo	+	—
Lutreola	+	+
Putorius	+	+
Mustela	+	—
NYCTEREUTES	—	+
Vulpes	+	+
CYON	—	+
Canis	+	+
Hyæna	—	+
Genetta	—	+
Herpestes	—	+
Lynx	+	+
Felis	+	+
Macacus	—	+

similarity of the climatic conditions of the two regions; and to the corresponding similarity in their mammalian life, as well as of their general faunal and floral facies.

In this connection it will be instructive to compare somewhat in detail the land mammals of the North American and Eurasiatic Regions, that is, omitting the Seals and the Sea Otter. We will also exclude the strictly Arctic genera—*Ovibos* and *Thalassarctos*. With these restrictions we have 75 genera for the North American Region and 97 for the Eurasiatic Region. These are enumerated in the accompanying table, where they are divided into four categories, as follows: (1) North American, subdivided into (*a*) Cold Temperate, (*b*) Warm Temperate; (2) Eurasiatic, subdivided into (*a*) Cold Temperate, and (*b*) Warm Temperate. By the use of distinctive type, the circumpolar genera and the genera peculiar respectively to the two Regions are distinguished from those having a more or less wide distribution to the southward of the North Temperate Realm. (See pp. 208, 209.)

The total number of genera tabulated is 140, a number of genera which barely enter the southern portion of the area under consideration being excluded as not properly pertaining to it. Of these 140 genera 75 are found in North America and 97 in Eurasia, the Eurasiatic Region, as would be expected from its much larger and more diversified area, having considerably the larger number. Of these 32 are circumpolar, and thus are common to the two regions, while quite a number of others are closely-allied representative genera. Thus nearly one-half of the North American genera are either identical with or closely related to Eurasiatic genera, while only a little more than one-third of the total number are respectively peculiar to one or the other of the two regions, namely: for the North American 27 out of 75, and for the Eurasiatic 40 out of 97, or 67 out of a total of 140.

If we compare, however, the Cold Temperate Subregions of the two Regions we find that out of 43 genera characteristic of the Cold Temperate Subregion in North America 32, or about three-fourths, are circumpolar, and that of the 49 genera of the Cold Temperate Subregion of the Eurasiatic Region 32 are also of course circumpolar. We find further that in the North American Region 17 out of the 27 peculiar genera do not extend north of the Warm Temperate Subregion; that 6 are common to both subregions, while 4 are peculiar to the Cold Temperate Subregion. Also that in the Eurasiatic Region 30 of the 40 peculiar genera are confined to the Warm Temperate Subregion, that 4 are common to both subregions, while 6 only are peculiar to the Cold Temperate. Consequently the peculiar genera of the two Cold Temperate Subregions, taken together, number only 10 out of a total of 140. This shows that the chief difference between the Eurasiatic and North American Regions is confined respectively to their warm temperate subdivisions, less than one-third of their peculiar or distinctive genera occurring in their cold temperate subdivisions. It is also of interest to note that the peculiar genera of the North American Region belong mainly to two or three families of Rodents—particularly the Heteromyidæ and the Geomyidæ—while many of the peculiar Eurasiatic genera belong to the Talpidæ, and in each case are restricted to comparatively limited areas.

The Sclaterian System.

While these and similar facts have been given due weight by the majority of writers on zoö-geography, there has been one notable exception to which it may not be out of place in the present connection to pointedly call attention. In 1858 Dr. P. L. Sclater, the eminent ornithologist and Secretary of the London Zoölogical Society, published a memoir on the geographical distribution of birds, in which he divided the earth's surface into two primary and four secondary zoölogical regions nearly in accordance with the principal land areas. His two primary regions are equivalent respectively to the eastern and the western hemispheres; or the Old World, termed 'Palæogæa,' and the New World, termed 'Neogæa.' These primary areas were divided on the same principle into (1) a Palæarctic Region, (2) a Nearctic Region, (3) a Palæotropical Region, (4) a Neotropical Region; thus entirely ignoring the close similarity of life throughout the cold temperate and arctic regions of the globe. These divisions, as has been urged recently in their favor,[1] are *convenient* and *easy to remember*, since they are approximately equal in size, are easily defined, and

[1] Wallace, Geogr. Distrib. Anim., Vol. I, pp. 63, 64.

avoid complicated boundaries. The names chosen for them have a classical appearance, are euphonius, and hence captivating. Moreover, this scheme of classification was based on a class of animals respecting which the proposer of the scheme is recognized as an eminent authority. At this time, and even for many years later, there were few special students in the field of zoölogical geography. Hence it was natural that the classification here laid down should meet with wide acceptance, particularly among English writers. Later its fallacies were exposed, and even several eminent English naturalists proposed much more rational schemes—as Huxley on the basis of birds, Günther of the British Museum on the basis of reptiles, and Blyth on general grounds, etc. Yet in 1876, Mr. A. R. Wallace, in his very useful and in many ways admirable work on the 'Geographical Distribution of Animals,' gave new life to the scheme by adopting it as the basis of his own classification, and attempting its defense. We may recognize this as a system based on continental areas, regardless of the actual distribution of life; and also as the Sclaterian method, in opposition to nearly all other systems, whether of botanists or zoölogists, who in general recognize that the distribution of life is in accordance with the climatic zones, in virtue of climatic influences, which the Sclaterian school consider as superficial and misleading. Like so many other misnomers, the terms 'Palæarctic' and 'Nearctic,' 'Palæotropical' and 'Neotropical,' have apparently become ineradicable, their convenience for the designation of particular geographic areas contributing to their adoption even by authors who protest against their use in their original sense.[1]

[1] Dr. Packard, in writing of the 'American Arctic Province' in 1883, speaks emphatically on this point as follows: "We reject the term 'Nearctic' proposed by Mr. P. L. Sclater, and adopted by Mr. A. R. Wallace, for America north of Central America, for the reason that it seems to us an unnatural and artificial term. The fauna is essentially American north temperate, while the Arctic regions of America and Europe-Asia form a realm by itself, of much less importance, it is true, than the north temperate realm (American and Europæo-Asiatic regions), when we consider the land plants and animals, but of nearly as much importance as regards marine life. To apply the term *Nearctic* to so vast a region as the American involves the idea that the region covers an area essentially arctic in its features. It is to be hoped that the term will not be adopted by American writers, as it is not by German and French writers, and we heartily endorse Mr. J. A. Allen's protest against the use of the term by American writers on this subject. The circumpolar or Arctic realm is a realm by itself, limited by the low degree of temperature and mainly bounded by the isothermal of 32°, and the adoption of this term will conduce, it appears to us, to clearer and more concise ideas of the geographical distribution of life on our continent."—*Twelfth Ann. Rep. U. S. Geol. and Geog. Surv.* (*Hayden*), pt. I, p. 363.

The Mammals of North America Considered in Relation to the North American Region and its Subdivisions.

Having now compared the North American Region with the Eurasiatic Region, we may proceed to an analysis of the North American Region itself. As shown by the table of distribution already given (pp. 208, 209), the North American Region is divisible into two Subregions, namely, a Cold Temperate and a Warm Temperate.[1] The most natural boundary for separating the two Subregions seems to be, in a general way, the northern limit of the successful cultivation of wheat, rye, barley, maize, peas, beans, hops, tobacco, potatoes and tomatoes, and the apple, peach and plum, or about the isotheral line of 65° F. This is approximately the boundary line separating the Alleghanian and Canadian Faunæ, as commonly recognized. The mammalian life of one of these two subregions differs vastly more from that of the other than does the mammalian life of the boreal parts of North America from that of the corresponding portions of Eurasia. The transition is, however, somewhat gradual. New elements appear near the southern boundary of the Cold Temperate, and increase in a rapidly progressive ratio as we proceed southward, while northern types fade out, and the general aspect eventually becomes radically changed.

The mammalian fauna of the Warm Temperate subdivision is found to consist of three pretty distinct elements: first, a generally diffused and more or less modified northern element, forming about one-fourth of the whole; second, a southern element, forming about another fourth; and third, an indigenous element, comprising about the remaining half. This of course is exclusive of the southward extension of purely northern forms along the various mountain ranges, which in a measure masks or obscures the general character of the fauna throughout the Rocky Mountain Plateau region.[2]

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[1] These subdivisions were recognized by me in 1878, but rather informally, and chiefly in a tabular way. See Bull. U. S. Geol. and Geogr. Surv., IV, pp. 339–343, and *passim* in the text at p. 337.

[2] Dr. Merriam has already called attention to the mixed origin of the fauna and flora of the middle temperate portion of North America is his discussion of the fauna and flora of San Francisco Mountain and the Painted Desert in Arizona (North American Fauna, No. 3, Sept., 1890, pp. 20–22).

To review briefly the leading characteristics of the region south of about the latitude of the Great Lakes, as compared with the area to the northward, we have as new elements among the Carnivores the Panther or Mountain Lion, the Bay Lynx instead of the Canada Lynx, the Gray Fox, the little Kit Fox and the Prairie Wolf, the Black-footed Ferret, the Raccoon, and the whole Skunk tribe represented by two genera and numerous species. Among the Ruminants the Prong-horned Antelope and the Bison; while the Caribou and the Moose of the north are replaced by an entirely different genus of the Deer tribe, represented by three species. Among the Rodents, we have an entirely new set of both Squirrels and Hares, and a greatly increased number of species of each; many new Field Mice, a ten-fold increase in the ground Squirrels and Spermophiles; also entirely new and numerously represented genera among the Field Mice, and three new families of other rodents, including some 20 to 30 species of Pocket Gophers, Kangaroo Rats and Pocket Mice. Among the Insectivores, in place of the single genus of small Shrews characterizing the northern region, we have not only new species but additional genera, and also the whole family of Moles, comprising several genera. In Bats, in place of a few straggling species which barely reach the milder parts of the high north, we have a very great increase in the number of both genera and species. We have further in the Opossum a distinctly tropical type.

Passing now down to near the southern border of this region we find still fewer northern types, but meet in their place a decidedly tropical element. In Texas, and along our southern border thence westward, we have the Armadillo, the Peccary, the Coati, the so-called Texas Civet-cat or Cacomistle, the Jaguar, the Ocelot, and leaf-nosed and big-eared Bats of several genera. Although the width of the continent along the 60th parallel is three times as great as it is along the 30th parallel, the number of species of mammals is probably ten times greater along the 30th parallel than it is along the 60th, and the life, so far as mammals are concerned, has become almost entirely changed, under the influence of the greatly altered climatic conditions.

As shown by the table of distribution already given (pp. 208, 209), 14 genera occur in the Cold Temperate which do not range to any extent into the Warm Temperate, namely:

Cervus,	Aplodontia,	Erethizon,
Alces,	Cuniculus,	Lagomys,
Rangifer,	Myodes,	Gulo,
Mazama,	Phenacomys,	Mustela.
Ovis,	Evotomys,	

On the other hand, 33 genera found in the Warm Temperate do not occur in the Cold Temperate, namely:

Didelphys,	Geomys,	Otopterus,
Dicotyles,	Perognathus,	Notiosorex,
Cariacus,	Microdipodops,	Blarina,
Antilocapra,	Dipodomys,	Scalops,
Cynomys,	Perodipus,	Scapanus,
Onychomys,	Antrozous,	Urotrichus,
Reithrodontomys,	Nycticejus,	Bassariscus,
Sigmodon,	Plecotus,	Conepatus,
Oryzomys,	Euderma,	Spilogale,
Neotoma,	Molossus,	Urocyon,
Thomonys,	Nyctinomus,	Felis.

The remaining 27 genera are to a greater or less extent common to both the Cold Temperate and the Warm Temperate. These genera are as follows:

Bison,	Arvicola,	Procyon,
Arctomys,	Sitomys,	Lutra,
Tamias,	Lepus,	Mephitis,
Spermophilus,	Vesperugo,	Taxidea,
Sciurus,	Atalapha,	Lutreola,
Sciuropterus,	Vespertilio,	Putorius,
Castor,	Sorex,	Vulpes,
Fiber,	Condylura,	Canis,
Synaptomys,	Ursus,	Lynx.

Hence while the two Subregions have much in common, and are thus thoroughly bound together, their differential elements are strongly marked. The 42 genera occurring in the Cold Temperate are either obviously of boreal origin, or find their nearest relationships with boreal types. Of the 62 genera occurring in the Warm Temperate Subregion, about 14 are wide ranging southern or subcosmopolitan types (some of them disappear before reaching the southern third of the subregion), 24 may be regarded as indigenous, and about 13 as of southern (tropical or subtropical) origin.

Continuing the analysis in further detail, we find that the following 28 genera of the North American Region are of either circumpolar or subcosmopolitan distribution and hence not distinctively North American, namely:

Cervus,	Castor,	Gulo,
Alces,	Evotomys,	Lutreola,
Rangifer,	Arvicola,	Putorius,
Bison,	Lagomys,	Mustela,
Ovis,	Lepus,	Vulpes,
Arctomys,	Vesperugo,	Canis,
Tamias,	Vespertilio,	Lynx,
Spermophilus,	Sorex,	Felis.
Sciurus,	Ursus,	
Sciuropterus,	Lutra,	

Only the remaining genera can therefore be considered as distinctively North American. These may be divided, according to their distribution, as follows:

Of general distribution, and thus distinctive of the North American region as a whole rather than of any particular subdivision:

Fiber,	Atalapha,
Synaptomys,	Mephitis,
Sitomys,	Taxidea.
Zapus,	

They are not, however, all evenly distributed throughout the region, *Taxidea*, for example, being absent from the southeastern States, while some of the others do not apparently extend northward beyond the middle of the Cold Temperate Subregion. On the other hand, *Mazama*, *Aplodontia*, *Latax*, and the subgenus *Neürotrichus* are of such local and peculiar distribution as not to be diagnostic of any of the lesser divisions, the first two being mountain forms and another (*Latax*) strictly littoral. *Erethizon* and *Phenacomys* are distinctive of the northern subregion; *Synaptomys* and the subgenus *Tamiasciurus* occupy a middle position, though mainly northern; *Condylura*, though of more local distribution, is not distinctively either northern or southern.

The remaining genera (with their subgenera, which it will be convenient to use in the present connection) do not range north of the Warm Temperate Subregion, though some of them extend far beyond it to the southward. Of these the following range over the subregion at large, and are consequently distinctive of the Warm Temperate Subregion as a whole:

Cariacus,	Scapanus,
Neotoma,	Urocyon.
Neosciurus,	

The remaining genera and subgenera are of comparatively limited distribution, and may be conveniently divided into four categories. First, however, may be eliminated a number of intrusive southern forms which are properly tropical and extend only a short distance over the southern border of the Warm Temperate Subregion. These are *Tatusia*, *Dicotyles*, *Heteromys*, *Molossus*, *Nyctinomus*, and *Nasua*; the first and the last (*Tatusia* and *Nasua*), and perhaps also *Heteromys*, though occurring north of the Rio Grande on the coast of Texas, appear to be really confined to the narrow northward extension of the American Tropical Realm along the lower coast of Texas, and thus really form no part of the proper fauna of the Warm Temperate Subregion. The four categories into which the remaining genera and subgenera may be divided are (1) *northern*, (2) *southern*, (3) *eastern*, and (4) *western*. The first two include the few types that range nearly across the continent from ocean to ocean as follows:

1. *Northern*.—Taken in a strict sense, the northern half of the Warm Temperate, has not a single genus, among those peculiar to the region, which ranges across the continent. By taking into consideration wide-ranging types, which reach this region (mainly) from the northward, we have the following as coming into the present category, namely: *Tamias*, *Lutreola*, *Zapus* and *Putorius*. *Tamias* (subgenus *Eutamias*), however, extends far southward in the West.

2. *Southern*.—The genera and subgenera that fall strictly into this category are few, even if we include besides those peculiar to the region, also those barely entering the region from the southward, as follows:

Didelphys,	Sigmodon,	Otopterus,
Dicotyles,	Oryzomys,	Corynorhinus,
Reithrodontomys,	Nyctinomus,	Spilogale.

Thus the northern and southern divisions of this subregion are distinguished mainly, so far as genera having a transcontinental distribution are concerned, by the presence of a number of types in the southern which do not reach the northern, only six of which, however, are strictly transcontinental.

3. *Eastern.*—The distinctively eastern genera and subgenera are the following:

Neofiber,	Nycticejus,
Blarina,	Parasciurus,
Scalops,	Tamias.

The first of these is local and southern; the others have a more general range.

4. *Western.*—The following list of 20 genera and subgenera are distinctively western or southwestern, only one of them (*Ictidomys*) occurring east of the Mississippi River.

Antilocapra,	Perodipus,	Otospermophilus,
Cynomys,	Onychomys,	Ictidomys,
Thomomys,	Antrozous,	Xerospermophilus,
Perognathus,	Euderma,	Ammospermophilus,
Chætodipus,	Molossus,	Bassariscus,
Microdipodops,	Notiosorex,	Conepatus.
Dipodomys,	Eutamias,	

All but two of these (*Molossus* and *Conepatus*) are indigenous to the region under consideration. *Geomys* may also be best placed here, though limited in its United States range to the plains and prairies east of the Rocky Mountains and to the coast region of the South Atlantic and Gulf States.

From the foregoing it is evident that the Cold Temperate and Warm Temperate Subregions differ greatly in respect to homogeneousness. No part of the Cold Temperate is very strongly differentiated from the rest of the subregion, whereas different parts of the Warm Temperate are found to be very unlike, even though situated under the same parallels of latitude. Hence the Warm Temperate admits of separation into two quite unlike parts, a western and an eastern, nearly on the line of the 100th meridian, while the Cold Temperate admits of no such subdivision.

The Major Faunal Areas of the North American Continent.

We are thus led to adopt the following scheme for the division of the North American continent into major faunal areas, as illustrated in the accompanying maps. First, the Arctic portion of the continent, or the region beyond the limit of arboreal vegetation, is to be assigned to the *Arctic Realm.* Second, the region south of the Mexican tableland, and also the low eastern coast region of Mexico north into Texas (about to Corpus Christi), and the low western coast region of Mexico north about to Mazatlan, may be assigned to the *American Tropical Realm*, with which also belong the extreme southern part of the Peninsulas of Lower California and Florida. Third, the remaining and by far the greater part of the continent belongs to the *North Temperate Realm*, of which it constitutes the *North American Region*.

The North American Region is divisible into two *Subregions*, namely, a *Cold Temperate* and a *Warm Temperate*. The latter comprises two *Provinces*, a *Humid* or Eastern, and an *Arid* or Western. The Humid Province is divisible into two *Subprovinces*, namely, an *Appalachian* or Northern, and an *Austroriparian* or Southern. The Arid Province is also divisible into two Subprovinces, namely, a *Campestrian* or Northern, and a *Sonoran* or Southern. The Campestrian Subprovince is susceptible of division into two or three *Districts*, as the *Great Plains District*, the *Great Basin District*, and a *Pacific Coast District*. Each of these areas usually consists of two or more minor divisions or *Faunæ*. (See accompanying maps, plates V–VIII.)

We will now pass in more formal review the faunal subdivisions of the North American Continent, from Region to Fauna, so far as the latter are at present clearly determinable.

The American Arctic.

If North America were isolated from the rest of the world it would be quite proper to treat the American portion of the Arctic Realm as merely a subdivision of the North American *Region;* but in view of the fact that it is really a part of a homogeneous hyperborean fauna of circumpolar distribution it seems more in accordance with general facts to consider it as a part of the Arctic Realm. The propriety of this seems especially emphasized when we consider that the "animals and plants inhabiting the Arctic regions are usually specifically identical throughout Arctic America, Greenland, and the polar parts of Eurasia and outlying islands," the "types inhabiting the Arctic Zone being few in number and uniform in character throughout their distribution."[1] The fauna of this Arctic Zone is thus no more American than it is Europæo-Asiatic, and differs far more from that of the adjoining region to the southward, both in North America and Eurasia, than does the American arctic from the Eurasian arctic. The Arctic Realm possesses only a small number of peculiar types in proportion to its area or in comparison with the other realms situated under more favorable conditions for the development of a diversified abundance of life; yet its peculiar types are quite numerous when considered in relation to the general meagreness of the fauna in these inclement latitudes. It is especially characterized by its poverty of life, and consequently largely by negative characters—by what it lacks rather than by a high ratio of peculiar forms.

The American Arctic[2] may be divided into two areas, which may take the rank of faunæ, or perhaps more properly of subfaunæ, in view of their slight inter-differentiation, namely: (1) the *Barren Ground Fauna*, and (2) the *Alaskan Arctic Fauna*.[3]

The Arctic American as a whole is characterized by being the home of the Eskimo, the Polar Bear, the Arctic Fox, the Arctic Hare, Parry's Marmot, the White Lemming, the Musk Ox, the Barren-ground Caribou, the Walrusses, and various species of Seals. Its southern boundary also forms the northern limit of nearly all of the characteristic species of the adjoining region southward, the greater part of which find their northern limit very near where the forest vegetation gives place to that of the Barren-grounds. The two faunæ into which this area appears separable are principally characterized by each having certain marine mammals along its coast not common to the other. The Alaskan Arctic has the Fur Seal, the Sea Lion, the Banded Seal, the Pacific Walrus, and the Sea Otter, neither of which occur in the region designated as the Barren Ground Fauna, which on the other hand has a few species, including the Musk Ox, not found in the Alaskan Arctic.

[1] Merriam, Proc. Biol. Soc. Wash., VII, pp. 39, 40.

[2] The American Arctic was ranked by me in 1871 (Bull. Mus. Comp. Zoöl., II, No. 2, p. 403) as a 'fauna' of the Arctic Realm, and termed the 'American Arctic Fauna.'

[3] The Alaskan Arctic Fauna is Mr. Edward W. Nelson's Alaskan Arctic District, characterized by him in his 'Report upon Natural History Collections made in Alaska,' 1887, pp. 27–32.

The North American Region.

The North American Region forms two *Subregions*, namely: (1) a *Cold Temperate Subregion*, extending southward to about the mean latitude of the Great Lakes, with outlying portions extending further southward along the principal mountain systems of the continent; and (2) a *Warm Temperate Subregion*, occupying the remainder of the North American Region. The differential features of the two subregions have already been shown in the analysis of the mammalian fauna of North America (see pp. 213–215).

I. Cold Temperate Subregion.—The Cold Temperate Subregion extends across the continent from the Atlantic to the Pacific, and from about latitude 43° northward to the limit of forest vegetation, with, however, a narrow prolongation southward along the Appalachian Highlands as far as northern Georgia, another in the interior along the main chain of the Rocky Mountains south into Mexico, and a third along the Cascade and Sierra Nevada ranges. Its southern border also sweeps to the northward, in the region of the Great Plains, so as to exclude the plains of the Saskatchewan, which belong to the Warm Temperate. It is subdivisible into two transcontinental *zones*, termed respectively the *Hudsonian* and *Canadian Zones*,[1] named from the two principal faunæ of which this subregion mainly consists. These zones correspond respectively with the Subarctic and Cold Temperate Zones of physical geographers and botanists.

The *faunæ* of the Cold Temperate Subregion are the *Hudsonian* and *Carolinian* in the east, and the *Aleutian* and *Sitkan* on the northwest coast, with a series of closely-related mountain faunæ or subfaunæ in the Rocky Mountains and the Sierra Nevada, as yet not well defined.

1. *Hudsonian Fauna.*—The Hudsonian Fauna occupies a belt at the northern border of the Cold Temperate Subregion, extending from Newfoundland to and across Alaska nearly to Bering Sea. It is thus bounded on the north by the Barren Ground Fauna, and west and northwest by the Alaskan Arctic Fauna. Its southern limit may be tentatively given as the isotheral of 57° F.

[1] See Merriam, N. Am. Fauna, No. 5, 1891, pp. 10–12, and *ibid.*, Proc. Biol. Soc. Washington, VII, 1892, p. 24.

The Hudsonian, as thus defined, forms the northern limit of a comparatively large number of mammals dependent upon forests for food and shelter. These are apparently the Red Fox, the Timber Wolf, the Black Bear, the Canada Lynx, the Weasels, Mink, Marten, Fisher, Wolverine, and the Otter; also of the Red Squirrel, the Flying Squirrel, the Jumping and other Mice, and the Varying Hare. These all enter the Hudsonian Fauna from the southward, and range northward to about its northern border. The northern limit of these various species is not in each case coincident, some ranging more or less beyond certain others, the exact limit being determined by the peculiar needs and habits of the species, and somewhat with local conditions. Hence here, as at the boundaries of faunæ generally, the species limited by a given fauna do not all stop along one abrupt line, but gradually fade out, one after another, within, however, comparatively narrow and locally varying limits.

The Hudsonian Fauna is further characterized by forming the southern limit of several species of Seals, as the Gray, Hooded and Harp, the Barren-ground Caribou, the Tawny Lemming, and the Yellow-cheeked Meadow Mouse, which range southward over this fauna from the Arctic Realm. The Hudsonian Fauna is thus distinctively characterized by the assemblage of species just enumerated, which occur together nowhere else.

2. *Canadian Fauna.*—The Canadian Fauna, like the Hudsonian, forms a nearly transcontinental belt, with the southern border of the Hudsonian for its northern boundary. It apparently includes a small portion of southwestern Newfoundland, nearly all of the provinces of New Brunswick and Quebec, northern Ontario, the northern half of New England, northern Michigan, the northern border of Wisconsin, and northeastern Minnesota. West of Lake Superior it stretches northwestward in a broad belt to the Peace River and northern British Columbia districts of Canada. It thus extends across the Rocky Mountains nearly to the Pacific coast. Its southern border trends at first southward, reaching its most southern point in the interior in northern Michigan and northeastern Wisconsin; it then runs northwest along the border of the plains, till it nearly or quite reaches the 55th parallel, when it then descends, west of the Saskatchewan Plains, as a narrow belt

along the eastern base of the Rocky Mountains, as far as northeastern Montana, with a further southward extension in the mountains proper. West of the Rocky Mountains it appears not to descend below the southern boundary of British Columbia, but runs southward in the mountains to an as yet undetermined limit. To the westward it is cut off from the Pacific coast by a distinctively coast belt. It has outlying insular areas in the Adirondack region of New York and on the higher crests of the Appalachian Highlands; it also forms a zone in the Rocky Mountain chain and its outlying ranges.[1]

The Canadian Fauna forms the northern limit of the common Skunk, the Star-nosed Mole, the Hoary, Red and Brown Bats, the northern form of the common Striped Squirrel, the Woodchuck, and the Virginia Deer. It also forms the southern limit of the Canada Lynx, the Wolverene, Pine Marten, Moose, Caribou, Canada Porcupine, and various species of Short-tailed Meadow Mice of the genus *Phenacomys*, etc.

3. *Sitkan Fauna.*—This is the 'Sitkan District,' as defined by Mr. E. W. Nelson.[2] It is of limited area, being confined to a narrow strip along the Pacific coast of Alaska, extending from Bristol Bay to about the southern end of the Territory of Alaska. So far as mammals go it has very little to distinguish it from the Canadian Fauna, of which it is practically little more than a littoral district. It is characterized by a few local forms of wide-ranging species, particularly of birds, and probably of animal life in general. It is a region of heavy precipitation and overcast skies, the climatic effect of which is strongly shown in the great intensification of color which marks most of the species coming within its influence. For this reason it seems entitled to recognition as a distinct faunal area of low rank.

4. *Aleutian Fauna.*—This is the 'Aleutian District' of Mr. E. W. Nelson,[3] previously termed by me the 'Aleutian Fauna.'[4]

[1] On the southern boundary of the Canadian Fauna in the East, see Verrill, Proc. Bost. Soc. Nat. Hist., Vol. X, p. 260, and Allen, Bull. Mus. Comp. Zoöl., Vol. II, p. 398. See also Dr. Merriam's Map 5 in 'North American Fauna' No. 3, where the southern boundary of his Boreal Province may be taken as the southern boundary of the Canadian Fauna.

[2] Rep. Nat. Hist. Coll. made in Alaska, 1887, pp. 24-26.

[3] *Ibid.*, 1887, p. 26.

[4] Bull. Mus. Comp. Zoöl., II, 1871, p. 401.

It includes not only the Aleutian chain of islands, but also the western and southern portions of the Alaskan Peninsula and probably the island of Kadiak, although this may more properly belong to the Sitkan Fauna. So far as mammals are concerned there is very little to distinguish the Aleutian Fauna, but it is well characterized by its bird life.

Both the Hudsonian and the Canadian Faunæ are represented in the higher parts of the Cascades, and in the more northerly parts of the Rocky Mountains in the United States, including their outlying spurs in both Idaho and Montana. More to the southward, in Utah and Colorado, and thence further southward in New Mexico, Arizona, and in Mexico, and also in the mountains of California, a few new elements come in, the differentiation being progressive toward the southward. Our knowledge of the mammalian life of these subalpine regions is, however, still too limited to render practicable any attempt in the present connection to define or characterize these southern extensions of the Hudsonian and Canadian life zones. We are thus far indebted to Dr. C. Hart Merriam, Chief of the Division of Mammalogy and Ornithology of the Department of Agriculture, for most of the exact knowledge we at present possess on the subject, and for a very successful attempt to correlate the life zones of some of our western mountain areas with those of the northern part of the continent. In the San Francisco Mountain region in Arizona he has very clearly traced[1] seven life zones and in part correlated them with the corresponding life areas of the continent at large. He subsequently extended[2] his careful methods of field work to the mountains of South-Central Idaho, with like praiseworthy and satisfactory results. The zones recognized in the San Francisco Mountain region and their correlations may be indicated as follows:

Zone.	*Fauna.*
Alpine	Arctic.
Subalpine or Timber-line	Arctic.
Hudsonian or Spruce	Hudsonian.
Canadian or Fir	Canadian.
Neutral or Pine	Alleghanian.
Piñon or Cedar	[Carolinian].
Desert	[Louisianian].

[1] N. Am. Fauna, No. 3, 1890, pp. 7–34 and maps 1–4.
[2] *Ibid.*, No. 5, 1891, pp. 9–12, 21–25.

II. Warm Temperate Subregion.—The Warm Temperate Subregion occupies middle North America, extending from the Cold Temperate Subregion on the north to the American Tropical Realm, as already defined, on the south. It thus includes the greater part of the United States, Lower California, and the Mexican tableland. It is cut into along the principal mountain systems by the southern prolongations of the Cold Temperate Subregion, and also extends northward over the Saskatchewan Plains. The extreme southern parts of the peninsulas of Florida and Lower California, however, are excluded, as also the lower coast region of Texas, these excluded districts, though of comparatively small extent, belonging to the Tropical Realm.

The Warm Temperate Subregion, regarded as a whole, is very unlike the comparatively homogeneous Cold Temperate Subregion, as already shown (pp. 213–218). It is vastly more varied in its physical features, is situated for the most part under climatic conditions more favorable to abundance and diversity of life, and thus presents a greater proportion of peculiar types, and also a larger number of more sharply contrasted faunal areas. Its life is largely indigenous, with, however, a strong infusion of both northern and southern elements. The indigenous elements appear to have had their origin in the Mexican plateau region, and are thus properly designated as Sonoran. The following list of mammalian genera and subgenera may be safely placed in this category:

Cariacus,	Thomomys,	Spilogale,
Antilocapra,	Dipodomys,	Notiosorex,
Cynomys,	Perodipus,	Scalops,
Xerospermophilus,	Microdipodops,	Scapanus,
Ammospermophilus,	Perognathus,	Corynorhinus,
Reithrodontomys,	Chætodipus,	Euderma,
Onychomys,	Bassariscus,	Antrozous.
Geomys,	Conepatus,	

The genera of tropical origin are:

Didelphys,	Sigmodon,	Molossus,
Dicotyles,	Neotoma,	Nyctinomus,
Oryzomys,	Procyon,	Otopterus.

Only two of these, *Neotoma* and *Procyon*, extend very far northward.

Besides the above, several genera of wide distribution beyond North America also occur, as

Lepus,	Spermophilus,	Vulpes,
Castor,	Lutra,	Lynx,
Sciurus,	Mustela,	Felis,
Sciuropterus,	Putorius,	Vesperugo,
Tamias,	Canis,	Vespertilio, etc.

Several American genera of rather extended range to the northward also occur, as *Sitomys*, *Fiber*, *Atalapha*, *Mephitis*, *Taxidea*, etc.

Nomenclature and History.—Before passing to a detailed consideration of the subdivisions of the Warm Temperate Subregion, it may be proper to refer briefly to its nomenclature and history, as treated by previous authors. This region, as here defined, consists of the southern portion of Baird's Eastern Province, together with his Middle and Western Provinces. As early as 1878[1] I separated the 'North American Region' into two *Subregions*, namely, a *Cold Temperate Subregion* and a *Warm Temperate Subregion*, as is done in the present paper, using these terms as headings in tables giving the distribution of the genera of North American Mammals. Baird's 'Eastern,' 'Middle,' and 'Western' *Provinces* were recognized as "natural regions," with the designation of 'Provinces,' but with the Eastern Province modified so as to restrict it to the Warm Temperate Subregion, and all three reduced in grade to regions of the third rank[2] instead of the second rank, as regarded by Professor Baird.

In 1883 Dr. Packard[3] substantially adopted this classification in treating of the faunal regions of North America, with, however, a change of name for the 'Cold Temperate Subregion,' he adopting for it that of 'Boreal Province'—an unfortunate suggestion of my own made later in the paper above cited (l. c., p. 376, where, in some unaccountable way my former division of the 'North Temperate Realm' into 'Subregions' was wholly overlooked!). Dr. Packard, in his otherwise excellent 'Zoö-geographical Map of North America,' failed, however, to recognize the southward

[1] Bull. U. S. Geol. and Geogr. Survey (Hayden), IV, 1878, pp. 338–344.

[2] That is, of the North American Region; really of fourth rank, considered from the basis of the world as a whole.

[3] Twelth Ann. Rep. U. S. Geol. and Geogr. Survey (Hayden), pt. I, 1883, pp. 362–370, and map; the latter republished in the Third Rep. U. S. Entomol. Comm., 1883, map iv.

extension of the Cold Temperate Subregion along the principal mountain systems of the continent.

Dr. Merriam in 1890[1] again set off the Cold Temperate Subregion, under the name 'Boreal Province,' and mapped in detail its southern prolongations into the mountainous parts of the Warm Temperate. The Warm Temperate Subregion was also recognized as a contrasting region of coördinate rank, under the designation 'Sonoran Province,' while the old 'Eastern,' 'Middle,' and 'Western' Provinces were properly repudiated as having no basis in nature. Particularly is this the case in respect to the Central Province, of which Dr. Merriam observes: "The region almost universally recognized by recent writers as the 'Central Province' is made up of the Great Plains, the Rocky Mountains and the Great Basin. A critical study of the life of the Rocky Mountains has shown it to consist of a southward extension of the Boreal Province, with an admixture of southern forms resulting from an intrusion or overlapping of representatives of the Sonoran Province, some of which, from long residence in the region, have undergone enough modification to be recognized as distinct subspecies or even species. A similar analysis of the Great Plains and Great Basin has shown them to consist of northward extensions of the Sonoran Province, somewhat mixed with the southernmost fauna and flora of the Boreal Province. Thus the whole of the so-called 'Great Central Province' disappears.

"This explains a multitude of facts that are utterly incomprehensible under the commonly-accepted zoölogical divisions of the country. These facts relate particularly to the distribution of species about the northern boundaries of the supposed Central and Pacific Provinces, and to the dilemma we find ourselves in when attempting to account for the origin of so many primary life areas in a country where there are no impassable physical barriers to prevent the diffusion of animals and plants."[2]

Dr. Merriam's generalizations respecting the Central Province of authors mark an important advance in the study of North American bio-geography. Taking this region with its original boundaries and significance it is a highly artificial division, em-

[1] N. Am. Fauna, No. 3, Sept. 1890, pp. 24–26, and map 5; see also Proc. Biol. Soc. Washington, VII, 1892, pp. 21–40, and accompanying map.

[2] N. Am. Fauna, No. 3, pp. 22, 23.

bracing within its area very unlike faunal elements. Eliminating from it, however, the broad central arm of the 'Boreal' or Cold Temperate Subregion, which occupies so much of the great central plateau, relieves it of an extraneous element, and reduces it to a more natural and geographically quite different region.

As already seen, Dr. Merriam selected for his two primary divisions of the North American Region the terms 'Boreal' and 'Sonoran' *Provinces*. These regions, both as to grade and nomenclature, were at first apparently adopted provisionally, as he says, in speaking of the United States: "Indeed, the present investigation demonstrates that there are but two primary life provinces in this country: a northern, which may be termed *Boreal*, and a southern, which, for our purposes, may be termed *Sonoran*, since it comes to us from Mexico through Sonora."[1] Later, however, he has termed these divisions 'Regions' instead of 'Provinces,' but has continued the use of the terms 'Boreal' and 'Sonoran.' The term Sonoran is thus applied to a region identical in geographical extent with the Warm Temperate—a designation previously used for the same area—and hence includes the whole region east of the Mississippi (as well as that west of it), from the Great Lakes and southern New England south to Florida and the Gulf Coast. The terms 'Sonoran' and 'Sonoran Province' were used, however, as early as 1866 by Prof. Cope,[2] and also later by Cope, Heilprin, and others, for a region of comparatively small extent, consisting of Sonora and adjoining portions of Arizona and New Mexico. In 1887 Heilprin[3] extended the region to include "the peninsula of Lower California, the State of Sonora in Mexico, New Mexico, Arizona, and parts, not yet absolutely defined, of Nevada, California, Texas, and Florida," and modified its title by calling it the 'Sonoran Transition Region.' The Sonoran Province or Region of these authors is thus not at all the 'Sonoran Region' of Merriam, which is an area of much greater extent and of higher rank. The term Sonoran, used in this extended sense, seems at least inappropriate if not misleading, as there are few if any strictly 'Sonoran' types represented in that portion of the United States

[1] N. Am. Fauna, No. 3, p. 19.
[2] Proc. Acad. Nat. Sci. Phila., 1866, p. 300.
[3] The Geogr. and Geol. Distrib. of Anim., p. 106.

situated to the eastward of the Mississippi River. The more descriptive and appropriate designation of 'Warm Temperate' is therefore preferred for the region in question, since it not only has priority but is in harmony with the terms Arctic, Cold Temperate, and Tropical, used currently for other coördinate areas of the continent.

Dr. Merriam in his important contributions to North American bio-geography has evidently not attempted to devise a systematic scheme of terminology and classification for the various grades of faunal areas, but, at first at least, simply employed provisionally such terms as would suffice to clearly indicate the regions under consideration, his attention being mainly and most successfully given to an elucidation of the facts of distribution. In following out, in the present connection, a consistent scheme of nomenclature, first attempted many years ago, the aim is to fix definitely designations for areas of different grades, and to combine the whole into a consistent system of classification. The nomenclature of the subject has ever been in such a chaotic and inharmonious state that a strict 'rule of priority' cannot be enforced, the same terms having been used in widely different senses, while not unfrequently a number of different names have been given to the same area. As already explained (p. 204) the system here proposed in respect to the *rank* of areas of different grades, as from Realm to Fauna, is analagous to the systematic schemes of classification in biology, and also in stratigraphic geology. The selection of distinctive names for divisions of the higher grades has relation to the influences controlling the geographic distribution of life, namely, *climate*, and hence it is natural that the climatic zones and their principal subdivisions should suggest the names of many of the major ontological areas. This indeed has been the custom to a large extent with both botanists and physiographers, and has often been practiced by zoölogists. Thus 'Humid' and 'Arid' become appropriate and suggestive designations for the eastern and western subdivisions of the North American Warm Temperate Subregion. For the lesser regions geographical names, as 'Hudsonian,' etc., are admirably appropriate when suggestive of some characteristic portion of the region in question. Whenever feasible, names first given should of course be retained in preference to later names. Furthermore, the terms indicative of grade should be used with the same uniformity and strictness as are the terms order, family, genus, etc., expressive of rank, in biology.

Provinces of the Warm Temperate.—The Warm Temperate Subregion, considered as a whole, is primarily divisible into two *Provinces*, namely, (1) a *Humid Province*, extending from the Atlantic Coast to the vicinity of the 100th meridian, and (2) an *Arid Province*, extending from the western border of the Humid Province to the Pacific coast, excluding of course all the higher mountain ranges, which are more or less wooded and constitute southern extensions of the Cold Temperate Subregion.

The Humid Province, as the name implies, has a humid climate and is in general heavily forested; the Arid Province is a dry region, some of it excessively arid, and consists mainly of open plains and deserts. It is highly diversified in respect to its physiographic features, and presents consequently a more varied fauna than is met with in the Humid Province. As already shown (p. 218) these two provinces are distinguished by the occurrence in each of a few peculiar types not possessed by the other, the Arid Province, however, having by far the greater number of peculiar types, owing to the large continuous land area extending from its southern boundary southward, from which direction much of its life has been derived, while the Humid Province has for its southern boundary a wide expanse of sea, namely, the Gulf of Mexico.

These two provinces thus coincide with the two strongly-marked climatic divisions of the middle, or United States, portion of North America in respect to rain-fall. Unlike the major divisions heretofore characterized (realms, regions and subregions), and also unlike the transcontinental zones, they are not separated by isothermal lines, trending in an east and west direction, but by a north and south line determined by the amount of rain-fall. Thus, in the present instance, temperature as a climatic influence governing the distribution of animals and plants is subordinated to the other leading climatic influence, humidity, which varies greatly in these two contrasting regions, in consequence of the long-continued peculiar physiographic and geographic conditions of the two regions. The many peculiar or indigenous types characterizing the Arid Province as compared with the Humid owe their existence, as already intimated, to the adjoining broad land area stretching far to the southward, whence they have been in large part derived, as contrasted with the absence of such a land area adjoining the Humid Province on its southern border. A large proportion of these peculiar types extend northward to the northern border of the Arid Province, or across the whole breadth of the Warm Temperate Subregion. The Warm Temperate Subregion is further subdivisible in a transcontinental direction into two zones, which might be termed a North Warm Temperate and a South Warm Temperate, as shown later on, but neither would be characterized by any considerable number of transcontinental genera. The northern belt would be characterized by less than half-a-dozen Cold Temperate genera which range a little way into the Warm Temperate, and the southern belt by about the same number of semi-tropical genera which extend into it from the southward. The remaining genera of the Warm Temperate are either wide-ranging transcontinental genera common to both belts, or else genera peculiar to either the Arid or the Humid Province.

The transition between the Humid and Arid Provinces is nowhere abrupt; they gradually merge into each other everywhere along their line of junction, as the prairies of the Mississippi Valley gradually become more arid and take on the characteristic aspect of the more arid plains. There is thus here the usual 'transition' belt occurring between contiguous faunal areas. It is, however, rather broader than between regions where temperature is primarily the limiting influence, as in the case of boundaries trending in a nearly east and west direction, the transition being first from a forested region to one of fertile prairies, and thence to arid plains and deserts. The dividing line may be considered as coincident with the isohyetal curve marking an annual rain-fall of 20 inches or less, as shown on rain-fall charts of the United States—hence, as above said, near the 100th meridian.

As already stated, the regions here designated as Humid and Arid 'Provinces' coincide with the 'humid' and 'arid' portions respectively of Dr. Merriam's 'Transition,' 'Upper Sonoran,' and

'Lower Sonoran' *Zones;*[1] he thus recognizing, but in a somewhat different way, the Humid and Arid areas here classified as *Provinces*.

Humid Province.—The Humid Province corresponds to the warm temperate part of Prof. Baird's 'Eastern Province,' and is exactly coincident with Dr. Merriam's 'Humid Sonoran' and 'Humid Transition.'[2] It comprises the United States east of the Great Plains, including also southeastern Ontario and the upper St. Lawrence Valley, but excluding northern New England, a portion of northern New York, northern Michigan and northern Wisconsin, and the higher crests of the Alleghanies. It contains a few genera and subgenera which do not occur in the Arid Province, as *Nycticejus*, *Blarina*, *Scalops*, *Condylura*, *Neofiber*, *Parasciurus* and *Tamias* (restricted subgenus). It lacks about 20 genera and subgenera that are confined in their eastward range to the Arid Province.

The Humid Province is separable into two *subprovinces*, namely, (1) an *Appalachian Subprovince*, and (2) an *Austroriparian Subprovince*.

Appalachian Subprovince.—The Appalachian Subprovince consists of the Alleghanian and Carolinian Faunæ, with the boundaries as long recognized by ornithologists and mammalogists, and as recently revised and mapped by Dr. Merriam.[3] It is characterized by the presence of a number of somewhat northern genera and subgenera which do not extend south of the southern boundary of the Carolinian Fauna, namely:

Arctomys,	Mynomes,	Synaptomys,
Tamias,	Pitymys,	Condylura.
Tamiasciurus,		

It is further characterized by the absence of a considerably greater number of southern genera and subgenera which do not pass north of its southern border, as enumerated in the next paragraph.

[1] Proc. Biol. Soc. Washington, VII, pp. 27–31, and accompanying map.
[2] *Ibid.*, pp. 27 and 30, and accompanying map.
[3] North Am. Fauna, No. 3, Map 5.

Austroriparian Subprovince.—The Austroriparian Subprovince consists of the long-recognized Louisianian Fauna, or 'Austroriparian' Fauna, as sometimes termed. Its fauna differs so much from that of the Appalachian Subprovince that they form two strongly-contrasted faunal areas. It is reached by few northern types, southern forms prevailing, to which are added genera of wide general distribution, like *Lutra, Canis, Vulpes, Sciurus, Sciuropterus, Lepus*, etc. It is characterized by the absence of the genera tabulated in the preceding paragraph, and by the presence of a larger number of others which do not extend north of its northern boundary, namely:

Reithrodontomys,	Neotoma,	Spilogale,
Oryzomys,	Neofiber,	Corynorhinus,
Sigmodon,	Geomys,[1]	Nyctinomus.

FAUNÆ OF THE HUMID PROVINCE.—The Humid Province, as here limited, has long been divided into three *Faunæ*, as follows: (1) *Alleghanian Fauna;* (2) *Carolinian Fauna;* (3) *Louisianian Fauna.* They have been so long recognized, and of late so clearly defined, that their boundaries have become well known.[2]

1. *Alleghanian Fauna.*—The northern border of the Alleghanian Fauna forms about the northern limit of the Panther, the Bay Lynx, the Raccoon, the Mole Shrew, the common and Brewer's Moles, the Gray Squirrel, and the Wood Hare. Its southern border forms about the southern limit of the Fisher, the Ermines, the Harbor Seal, the Elk (in former times), the Northern Striped Squirrel, several species of Field Mice (genera *Evotomys* and *Synaptomys*), the varying Hare, etc. It also forms the northern limit of the Cat and Fox Squirrels (subgenus *Parasciurus*), the Opossum, and various other species soon to be mentioned in characterizing the Carolinian Fauna. The Alleghanian Fauna is thus characterized by the overlapping and commingling of a particular set of species not found elsewhere associated. It is bounded on the north by the Canadian Fauna, on the south by the Carolinian Fauna, and extends westward to the edge of the Great Plains.

[1] So far as its distribution east of the Mississippi River is concerned.

[2] See Allen, Bull. Mus. Comp. Zoöl., II, pp. 395–397; Merriam, North. Am. Fauna, No. 3, map No. 5. Respecting especially the southern boundary of the Alleghanian Fauna, see Bicknell, Bull. Nutt. Orn. Club, III, p. 128; Allen, *ibid.*, p. 149; Chapman, Auk, VI, p. 179.

2. *Carolinian Fauna.*—The northern boundary of this fauna forms in a general way the northern limit of the Gray Fox, the Northern Fox Squirrels, the Pine Mouse, the Opossum, and a Bat of the genus *Nycticejus.* It also forms the southern limit of the Star-nosed Mole, the common Red Squirrel, the Southern Chipmunk, the Woodchuck, the Muskrat, and the common Meadow Mouse (*Arvicola riparius*).

3. *Louisianian Fauna.*—The Louisianian Fauna joins the Carolinian Fauna on the south, and occupies the rest of the Eastern United States to the southward, excepting the extreme southern portion of the peninsula of Florida, which has long been recognized as a *Floridian Fauna*, and as belonging to the Antillean Subregion of the American Tropical Realm. The Louisianian Fauna is characterized by the possession of a number of both genera and species not found north of its limits, although most of the Louisianian genera have a wide distribution southward in Mexico, and westward and northwestward, where, however, they are commonly represented by different species. The characteristic elements of the Louisianian Fauna are the Wood Rat, Cotton Rat, Cotton Mouse, Golden Mouse, Rice-field Mouse, Harvest Mouse, Pocket Gopher, the Southern Gray and Southern Fox Squirrels, the Marsh Hare, Swamp Hare, Little Striped Skunk, and a species each of Big-eared and Leaf-nosed Bats. These represent eight genera not found in the Carolinian Fauna, as follows: *Neotoma*, *Sigmodon*, *Oryzomys*, *Reithrodontomys*, *Geomys*, *Spilogale*, *Corynorhinus* and *Nyctinomus.*

Several interesting facts may be here noted in relation to the faunæ of the Humid Province of the Warm Temperate Subregion as compared with the eastern tier of faunæ in the Cold Temperate Subregion. While the Alleghanian, Carolinian and Louisianian Faunæ terminate at the eastern border of the Great Plains, and hence extend over less than half the width of the continent, the Canadian and Hudsonian sweep across nearly its whole breadth, from the Atlantic coast nearly to the Pacific, and this too at a point where the continent presents its greatest breadth. The mammals and birds found from about the latitude of 43° northward extend as a rule uninterruptedly northwestward from the eastern seaboard over the comparatively low, generally forested interior to the Rocky Mountains and across Alaska almost to the Pacific coast. They also pass over the depressed portions of the Rockies in about latitude 57° to 59°, and follow the Peace and Liard Rivers to the sources of the Yukon, spreading thence northward and westward to the coast ranges of southern Alaska. In fact, the Rocky Mountains, as is well known, present too many points of depression to form much of a barrier to the dispersion of species, so that from southwestern British Columbia northward, except along the coast, the fauna is nearly identical with that of eastern Canada and northern New England. The arid, treeless plains of the interior thus form a greater barrier to the extension westward of eastern forms than do the Rocky Mountains themselves.

ARID PROVINCE.—The Arid Province extends from the eastern border of the Great Plains to the Pacific, and northward over the Saskatchewan Plains, the Plains of the Columbia, and thence north into southern British Columbia. It thus includes the so-called 'Central' and 'Pacific' Provinces of Baird and most subsequent writers, excepting of course the more elevated parts of the Rocky Mountain plateau. It is thus coëxtensive with Dr. Merriam's 'Arid Sonoran.' While it is true that a narrow belt along the Pacific coast from Southern California northward to the Alaskan Peninsula possesses a few peculiar types, and lacks a few of those occurring in the region immediately to the eastward, the differentiation is on the whole too slight to give to this Pacific coast district the rank of a region coördinate in grade with Baird's so-called Middle and Eastern Provinces.[1] These differences serve at best merely to mark off from the interior region at large a tier of narrow coast faunæ of the same grade as those bordering the Atlantic coast,

[1] In writing in 1871 of the 'Natural Provinces of the North American Temperate Region,' from the standpoint of Ornithology, I adopted the present classification, as shown by the following: "Within this Region may be recognized two Provinces—an Eastern and a Western—quite distinct from each other in their general features as well as in many special characteristics. The Eastern Province is characterized by the uniformity of its geographical and climatic features, and by a corresponding uniformity in its faunal and floral aspects. The Western Province, on the other hand, is characterized by the diversity of its geographical and climatic features—different areas situated under the same parallels differing greatly in these respects—and by the number and small extent of its zoölogical and botanical areas, and its comparatively numerous restricted floræ and faunæ.... The Western Region [*lege* Province] commences at the western border of the Eastern and extends thence to the Pacific coast."—*Bull. Mus. Comp. Zoöl.*, Vol. II, pp. 384, 385.

although the latter, owing to the widely different physiography of the eastern and western borders of the continent, have a much greater east and west extent.

The Arid Province is characterized by the presence of about 20 genera not found in the Humid Province, and by lacking a few occurring in the latter. The 20 genera and subgenera of the Arid Province not found in the Humid Province are the following:

Antilocapra,	Perodipus,	Otospermophilus,
Cynomys,	Onychomys,	Ictidomys,
Thomomys,	Antrozous,	Xerospermophilus,
Perognathus,	Euderma,	Ammospermophilus,
Chætodipus,	Molossus,	Bassariscus,
Microdipodops,	Notiosorex,	Conepatus.
Dipodomys,	Eutamias,	

Among its characteristic mammals are the Badger, Coyote, Kit Fox, Black-footed Ferret, Texas Civet Cat, the Mule and Black-tailed Deer, the Prong-horned Antelope, all of the numerous species and subspecies of the genus *Thomomys* and nearly all the species of *Geomys*, four genera and some thirty species of Kangaroo Rats and Pocket Mice, all of the several species of Prairie Dog, eight or ten species of Spermophiles, a dozen species of Ground Squirrels, including the whole subgenus *Eutamias*, all of the several species of Jackass Hares, all of the Grasshopper Mice (*Onychomys*), and numerous species of Bats, Shrews and Arboreal Squirrels.

Subprovinces of the Arid Province.—The Arid Province, like the Humid, is divisible into two subprovinces, namely, (1) a northern or *Campestrian Subprovince*, and (2) a southern or *Sonoran Subprovince*. These two regions correspond respectively with Dr. Merriam's 'Arid Upper Sonoran' and 'Arid Lower Sonoran'; just as the two subprovinces of the Eastern Province correspond with his 'Humid Upper Sonoran' and 'Humid Lower Sonoran,' as laid down on his 'Second Provisional Bio-geographic Map of North America,' except that the 'humid' and 'arid' portions of his 'Transition Zone' are also included respectively in the Alleghanian and Campestrian Subprovinces. The Sonoran Subprovince is equal to Dr. Merriam's restricted "Arid or Sonoran subregion proper" plus his "Lower Californian subregion," while the Campestrian Subprovince includes his "Great Basin subregion" and his "Great Plains subregion."[1] The name 'Campestrian' has reference to the fact that this subprovince is largely made up of plains, including as it does the greater part of the Great Plains, the Plains of the Saskatchewan, and the Plains of the Columbia and Snake Rivers. (See map, pl. VII.)

Many species are limited in their southward distribution by the southern border of the Campestrian Subprovince, but few genera appear to be thus restricted. This boundary also forms about the northern limit of many species and genera of the Sonoran Subprovince. These two subprovinces are hence characterized mainly by the presence of a large number of forms found in the Sonoran which are absent from the Campestrian, which is thus characterized, like many northern divisions when compared with adjoining southern ones of coördinate rank, from the Arctic southward, by what it lacks rather than by the possession of any peculiar types.

Districts of the Campestrian Subprovince.—The Arid Province is further divisible into a number of areas intermediate in rank between faunæ and subprovinces, which may be called *Districts.* Thus the Campestrian Subprovince is separated by the main chain of the Rocky Mountains into two areas each of which includes two or more faunæ, equivalent to and representative of the Alleghanian and Carolinian Faunæ of the Atlantic coast. These two areas are (1) the *Great Plains District,* consisting of the Great Plains region east of the Rocky Mountains from northern Texas to and including the Saskatchewan Plains; and (2) the *Great Basin District,* including the Great Basin region at large, from southern New Mexico, southern Utah, and southern Nevada north to the Plains of the Columbia and Snake Rivers, and thence northward over the more open and arid portions of eastern British Columbia. It encloses outlying spurs and insular areas of the Cold Temperate Subregion. These two districts possess few distinctive genera and but few distinctive species, though physiographically so well separated. A narrow Pacific Coast belt, situated mainly west of the Sierra Nevada and Cascade Ranges, may be recognized as (3) a *Pacific Coast District,*

[1] *Cf.* N. Am. Fauna, No. 3, p. 25.

characterized by the presence of a few species and a considerable number of subspecies mainly restricted to it. (See map, pl. VII.)

The *Sonoran Subprovince* is apparently not so distinctly separable into Districts of very marked distinctness, even the Peninsula of Lower California presenting few peculiar forms of higher grade than subspecies. Apparently, however, the main continental divide serves to separate a well-marked eastern from a well-marked western subdivision, each characterized by many species and subspecies not found in the other.

The ultimate faunal areas, or the *Faunæ*, of the Arid Province have not as yet been outlined, and their detailed treatment is beyond the scope of the present paper.

ZONES OF THE WARM TEMPERATE SUBREGION.—In addition to the subdivisions of the Warm Temperate already recognized, and independent of them, this subregion may be divided also into several *zones* or *belts* of transcontinental extent, namely, (1) *Alleghanian Zone*, (2) *Carolinian Zone*, and (3) *Louisianian Zone*—these names being based respectively on those of the long-known Atlantic coast faunæ, of which they respectively in part consist, just as 'Canadian' and 'Hudsonian' have been adopted for the transcontinental zones of the Cold Temperate.

The *Alleghanian Zone*, east of the Great Plains, consists of the Alleghanian Fauna; from the eastern edge of the Plains westward it consists of a succession of faunæ—one in the Great Plains District, another in the Great Basin District, and a third in the Pacific Coast District, as yet not clearly defined—equivalent in faunal character to and representative of the Alleghanian Fauna of the East. This zone has already been traced across the continent and mapped by Dr. Merriam under the name '*Neutral* or Transition Zone."[1] It was first recognized by him in his exploration of the San Francisco Mountain region in Arizona, under the name of 'Neutral or Pine Zone,"[2] and later

[1] Proc. Biol. Soc. Washington, VII, 1892, pp. 30–33, and accompanying map.
[2] N. Am. Fauna, No. 3, 1890, p. 11.

in Idaho.[1] In his later treatment of the subject he has strangely separated this zone as an independent region of minor grade, interposed between his two primary divisions of the continent! He says: "Interposed between the Boreal and Sonoran Regions throughout their numerous windings and interdigitations, is the Neutral or Transition Zone. The humid division of this zone, known as the Alleghanian Fauna, covers the greater part of New England....and extends westerly over the greater part of New York, southern Ontario and Pennsylvania, and sends an arm south along the Alleghanies all the way across the Virginias, Carolinas, and eastern Tennessee, to northern Georgia and Alabama. In the Great Lake region this zone continues westerly across southern Michigan and Wisconsin, and then curves northward over the prairie region of Minnesota, covering the greater parts of North Dakota, Manitoba, and the plains of the Saskatchewan; thence bending abruptly south it crosses eastern Montana and Wyoming, including parts of western South Dakota and Nebraska, and forms a belt along the eastern base of the Rocky Mountains in Colorado and northern New Mexico, here as elsewhere occupying the interval between the Upper Sonoran and Boreal Zones."[2]

The Alleghanian Zone is beyond question a transition belt, being necessarily so from its geographical position; its affinities, however, are decidedly with the Warm Temperate division of the continent rather than with the Cold Temperate, as the case was first interpreted by Dr. Merriam,[3] since its northern boundary coincides closely with the northern limit of distribution of a large number of southern genera of both plants and animals, including most of the staple grains and fruits of the Warm Temperate Zone.

As is well known, there is always a belt of neutral territory along the common boundary line of two adjoining areas, varying in breadth with the rank of the two areas; and the present case of the Alleghanian Zone is thus not exceptional. All things considered it therefore seems best to regard it as the northern transcontinental belt of the Warm Temperate rather than to give it the

[1] N. Am. Fauna, No. 5, 1891, p. 24.

[2] Proc. Biol. Soc. Washington, VII, 1892, pp. 30, 31.

[3] N. Am. Fauna, No. 3, p. 20, and *ibid.*, No. 5, pp. 21 and 25.

anomalous position of a minor faunal area interposed between and completely separating two areas of a higher grade.[1]

The *Carolinian Zone* consists of the Carolinian Fauna, with its several western equivalents. It correlates with the 'Piñon Zone' of Dr. Merriam, as recognized by him in the San Francisco Mountain Region,[2] and later in Idaho, under the designation of 'Arid Upper Sonoran Zone."[3] Taken as a whole it corresponds to what he has denominated Upper Sonoran.

The *Louisianian Zone* includes the Louisianian Fauna and its equivalent faunæ in the West. It may be correlated with Dr. Merriam's 'Desert Zone or Area' in Arizona,[4] which became later[5] his 'Arid Lower Sonoran Zone,' and is, as a whole, the same as his 'Lower Sonoran.'

It thus appears that extra-tropical North America may be separated into about six transcontinental belts or zones, for the purpose of conveniently correlating the numerous faunæ of the continent, as follows:

(1) An Arctic or Hyperborean Zone, coëxtensive with the American portion of the Arctic Realm.

(2) A Subarctic, Hudsonian or 'Spruce' Zone.

(3) A Cold Temperate, Canadian, or 'Douglass Fir' Zone.

(4) A Temperate or Alleghanian Zone.

(5) A Warm Temperate or Carolianian Zone.

(6) A Subtropical or Louisianian Zone.

Tropical North America.

It has long been recognized that the extreme southern portion of the Peninsula of Florida, the lower portion of the Rio Grande Valley, and a narrow belt extending thence northward for a

[1] In biology 'aberrant,' 'transition' or intermediate genera are frequently met with, and in some cases it is difficult to refer them to one of the two subfamilies to which they are allied rather than to the other. Yet we feel compelled to refer them to one or the other, or else to make a new subfamily for the aberrant genus, in case it shows sufficient differentiation, rather than to leave it as an isolated genus, with the rank of a genus, to be interposed between two subfamilies, or families, as the case may be.

[2] N. Am. Fauna, No. 3, pp. 12 and 20.

[3] *Ibid.*, No. 5, p. 25, and Proc. Biol. Soc. Washington, VII, p. 27.

[4] *Ibid.*, No. 3, pp. 13 and 20.

[5] Proc. Biol. Soc. Washington, VII, p. 28.

short distance along the Texas coast contain such a strong infusion of tropical types as to render these limited areas properly referable to the Tropical Realm, to which belong also all of the lowland of Mexico, including a narrow coast belt extending from the Rio Grande southward on the eastern coast and from Mazatlan southward on the western coast.

The fauna of neither of the tropical areas within the United States is typically tropical, but the infusion of tropical elements is so great as to render them tropical rather than temperate. They have also little in common with each other, as would be naturally anticipated from their wide geographical separation through the interposition of the Gulf of Mexico, thus preventing a tropical land connection. Consequently the Floridian area, or the *Floridian Fauna*, as it has long been technically known,[1] belongs to the Antillean Region of the American Tropical, while the Texan area is an outlying arm of the Central American Region of the American Tropical.

Floridian Fauna.—So far as mammals are concerned the Floridian Fauna has few distinctive elements. It has, however, a peculiar subspecies of the Wood Hare, and also of the Cotton Rat, and several species of Field Mice of the genus *Sitomys;* and the Manatee is a characteristic animal of the coast lagoons and rivers. From the standpoint of birds, insects, mollusks and plants, the Floridian Fauna is strongly characterized, not less than a dozen distinctly tropical genera of birds being represented, with a much larger infusion of tropical insects and mollusks.[2] Among the tropical birds which occur more or less regularly may be mentioned the Man-o'-War Bird, the Flamingo, the Florida Burrowing Owl, four West Indian species of Pigeons, the Ani, the Mangrove Cuckoo, the Dusky Seaside Sparrow, the Grassquit, the Black-whiskered Vireo, the Bahaman Honey Creeper, and various peculiar subspecies of northern birds.

Tamaulipan Fauna.—This semitropical area occupies the extreme lower portion of the Rio Grande Valley, probably not extend-

[1] *Cf.* Bull. Mus. Comp. Zoöl., II, 1871, p. 391.—The general provisional northern limit here given—"near the latitude of Lake George"—proves to have been carried a little too far north, its limits as now recognized being Cape Malabar on the east coast and Tampa Bay on the west coast. (*Cf. Merriam*, Proc. Biol. Soc. Washington, VII, 1892, p. 33.)

[2] *Cf.* Merriam, Proc. Biol. Soc. Washington, VII, 1892, pp. 52–54.

ing much above Hidalgo, and thus limited to within about the 100-foot contour line. It extends along the coast, mainly within the same contour line, northward to about the mouth of the Nuesces River, thence gradually fading out northward, a few tropical forms extending as far north as the mouth of the Colorado River, where a number of Louisianian forms gradually disappear. South of the Rio Grande it occupies the low coast region of Mexico southward nearly to Tampico. It thus includes the greater part of the State of Tamaulipas, and the southeastern part of the State of Nuevo Leon. Among mammals the following distinctively tropical forms are either limited in their northward range by the Tamaulipan Fauna, or extend but a little way beyond it:

Tatusia novemcinctus,
Heteromys alleni,
Dipodomys phillipsii,
Sigmodon hispidus texianus,
Oryzomys aquaticus,
Sitomys mearnsii,[1]
Atalapha intermedia,
Nasua narica,
? Putorius brasiliensis frenatus,
Felis eyra,
" yaguarandi,
" onca,
" pardalis.

The last two have been reported from as far north along the Texas coast as the Brazos River, but they are tropical rather than warm temperate species. *Dicotyles tajacu* also properly belongs here, though ranging a little further to the northward than do the others.

Among tropical birds that here reach their northern limit are the following:

Podiceps dominicus,
Ortalis vetula maccalli,
Engyptila albifrons,
Buteo albicaudatus,
Crotophaga sulcirostris,
Trogon ambiguus,
Nyctidromus albicollis merrilli,
Amazilia fuscicaudata,
" cerviniventris,
Pitangus derbianus,
Myiozetetes texensis,
Xanthoura luxuosa,
Embernagra rufivirgata,
Sporophila morelleti sharpei,
Euphonia elegantissima,
Vireo flavoviridis,
Compsothlypis nigrilora,
Geothlypis poliocephala palpebralis,
Basileuterus culicivorus,
Harporhynchus longirostris sennetti.

The Tamaulipan Fauna has fewer distinctively tropical types than would be expected from its low altitude and geographical position. This is doubtless due to the extreme aridity of the

[1] = *Vesperimus mearnsii* Allen, Bull. Am. Mus. Nat. Hist., III, p. 300.

country, since in the forest regions further inland under the same parallels Trogons, Motmots and Parrots occur to a much greater extent than in the arid, nearly treeless coast region.

Tabular Synopsis of the Faunal Areas of North America.

REALMS.	Arctic.	
	North Temperate.	
	American Tropical.	
REGIONS.	North American.	<*North Temperate Realm.*
	Central American.	<*American Tropical Realm.*
	Antillean.	
SUBREGIONS.	Cold Temperate.	=*North American Region.*
	Warm Temperate.	
PROVINCES.	Humid.	= *Warm Temperate Subregion.*
	Arid.	
SUBPROVINCES.	Appalachian.	=*Humid Province.*
	Austroriparian.	
	Campestrian.	=*Arid Province.*
	Sonoran.	
DISTRICTS.	Great Plains.	=*Campestrian Subprovince.*
	Great Basin.	
	Pacific Coast.	
FAUNÆ.	Barren Ground.	*Arctic.*
	Alaskan-Arctic.	
	Aleutian.	*Cold Temperate.*
	Hudsonian.	
	Canadian.	
	Sitkan.	
	Alleghanian.	*Humid Warm Temperate.*
	Carolinian.	
	Louisianian.	
	Floridian.	*Tropical.*
	Tamaulipan.	

Article XV.—CATALOGUE OF GALL-PRODUCING INSECTS FOUND WITHIN FIFTY MILES OF NEW YORK CITY, WITH DESCRIPTIONS OF THEIR GALLS, AND OF SOME NEW SPECIES.

By WILLIAM BEUTENMÜLLER.

This catalogue is based mainly upon specimens of galls in the collection of the American Museum of Natural History, which were gathered by me during 1889–92 inclusive, when collecting entomological material for the Museum and for the Jesup Collection of 'Economic Entomology.' To make the catalogue as complete as possible I have also added such species as have already been recorded, or reported to me as having been taken within the area specified. It was originally my intention to also incorporate the descriptions of the gall-flies, whenever known, but for various reasons I have omitted them from the present catalogue.

The vegetable deformations called galls are produced by insects. Generally an egg is inserted in a bud, a leaf, a root, or some other part of the plant, and the presence of this foreign body among the vegetable cells causes an abnormal growth of a definite shape. The variety of galls in respect to structure and substance is very great. Every species of gall-producing insect attacks its own particular plant and a particular part of that plant, and produces a gall of a definite and uniform structure.

The galls enumerated in this catalogue are produced by insects belonging to the following orders: (1) Hymenoptera (Cynipidæ and Tenthrenidæ); (2) Diptera (Cecidomyidæ and Trypetidæ); (3) Hemiptera (Aphidæ and Psyllidæ); (4) Arachnida (Mites). Besides these groups, which are the principal gall-producers, some few species of other insects also produce gall-like excrescences.

I am fully aware that this catalogue is incomplete, and that a considerable number of species will yet be added as soon as we have a better knowledge of the species of gall-insects found in the vicinity of New York City.

The figures accompanying this catalogue were drawn from nature by Mr. R. Weber, and are all natural size.

HYMENOPTERA.

CYNIPIDÆ.

Rhodites bicolor (*Harris*).

PLATE IX, FIG. 1.

Cynips bicolor HARRIS, Ins. Inj. Veget. 1841, p. 399.
Rhodites bicolor OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 43, 48.

Round, covered with numerous long prickly spines, almost as long as the diameter of the gall. In summer the gall is yellowish green, and is sometimes tinged with red. The perfect insect was briefly described by Harris (l. c.), and a detailed description was given by Osten Sacken (l. c.). Harris's types are in the collection of the Boston Society of Natural History. The species is common on the twigs of different kinds of wild roses, growing in clusters of two or more. Common.

Numerous specimens. Coll. Am. Mus. Nat Hist.

Rhodites ignota *Osten Sacken.*

PLATE IX, FIG. 2.

Rhodites ignota OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 43, 49.

This gall is round, about the size of a pea, and covered with a white mealy substance. Sometimes two or three of these galls coalesce, thus forming an elongated mass of more irregular shape. In texture the gall is hard and woody, and each contains several cells. I have taken it plentifully on the leaves of *Rosa carolina*, in September, at West Farms, New York City.

Two examples. Coll. Am. Mus. Nat. Hist.

Rhodites radicum *Osten Sacken.*

PLATE IX, FIG. 3.

Rhodites radicum OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 42, 46.

Found at the roots of various kinds of wild roses. The gall is irregularly rounded, and with a deep depression above and below at the place of attachment to the roots. It is smooth and reddish brown in color. The inside is composed of a pithy substance, and contains numerous cells. Taken on Staten Island by Mr. Wm. T. Davis and myself.

Six specimens. Coll. Am. Mus. Nat. Hist.

Rhodites globulus, n. sp.

PLATE IX, FIG. 4.

This is certainly the unnamed gall described by Osten Sacken (Proc. Ent. Soc. Phil., Vol. II, p. 42).

The gall is smooth, rounded and rises at each end abruptly from the branch. In substance it is rather soft and corky, with numerous cells inside. In form it is sometimes more or less oblong or is almost round, and measures from three-quarters of an inch to an inch and a half in length and is about three quarters of an inch in diameter. Found on Swamp Rose (*Rosa carolina*) on Staten Island.

GALL-FLY. *Male.*—Head jet black, not shining, rugosely punctate. Antennæ black. Thorax deeply corrugated, jet black above and below. Legs black with joints and tarsi yellowish brown. Body shining black, finely punctured. Length, 3 mm.

Female.—Differs from the male by having only the posterior pair of legs marked with black and the two other pairs wholly yellowish brown. It is also larger, with the anal valve considerably longer. Length, 5 mm.

Described from one male and one female. Types Coll. Am. Mus. Nat. Hist.

Rhodites dichlocerus (*Harris*).

PLATE IX, FIG. 5.

Cynips dichlocerus HARRIS, Ins. Inj. Veget. 1841, p. 399.
Rhodites dichlocerus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 41, 46.

This gall is an elongated, hard, woody swelling, gradually tapering at both ends. It occurs on the branches of *Rosa carolina*. The originator of the gall was briefly described by Harris (l. c.) and accurately characterized by Osten Sacken (l. c.). Taken at Kingsbridge, N. Y., and on Staten Island. Not common. I have examined the type specimen of the gall in the Museum of the Boston Society of Natural History.

Several examples. Coll. Am. Mus. Nat. Hist.

Rhodites verna *Osten Sacken.*

PLATE IX, FIG. 6.

Rhodites verna OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 41, 47.

Taken by me on Staten Island on the Wild Rose (*Rosa lucida*). The gall is somewhat allied to *Rhodites dichlocerus* Harr. It is oblong or rounded, and about one-third of an inch long. Sometimes there is a series of three or four such swellings attached to each other, and in this respect differs from *R. dichlocerus*. The figure here given was drawn from an authentic specimen in the Museum collection.

Rhodites rosæ (*Linn.*).

Cynips rosæ LINN. Syst. Nat. 10th Edit. Vol. I, p. 533.
Rhodites rosæ OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, p. 47; HARTIG, Zeitschr. f. d. Ent. II, 1840, p. 194.

This gall, according to Osten Sacken, is identical with the European species, where it is well known under the name of 'Bedeguar,' said to mean rose apple. In this country it occurs on the Sweet Briar (*Rosa carolina*). It is composed of an agglomeration of hard cells around a branch, and is wholly covered with long and dense green filaments, forming a moss-like mass an inch and a half or more in diameter. I have taken a gall of a similar nature on the leaves and stems of the common Blackberry (*Rubus villosus*) and which probably is identical with *Rhodites rosæ* Linn. Not common.

One example. Coll. Am. Mus. Nat. Hist.

Diastrophus bassettii, n. sp.

PLATE IX, FIG. 7.

The gall of this species was found by Mr. W. T. Davis on Staten Island, on the stems of the Trailing Blackberry (*Rubus canadensis ?*). It is irregularly rounded or somewhat elongated, and grows near the ground, but not beneath the surface as does *D. radicum* Bass. In color it is greenish, and is tinged with red. Inside there are numerous rounded cells in the pithy substance of which the gall consists. Mr. H. F. Bassett informs me that he also found this gall many years ago on the stems of the 'Trailing Blackberry,' but did not secure the gall-flies and therefore did not describe it. The gall is very different from that of *D. radicum* Bass., under which name it has been known to me for some time past, but comparing it with type specimens of *D. radicum*, kindly sent me by Mr. Bassett, I find it totally different. In cutting open one of the galls I found two mature flies and several partly-developed specimens.

The flies may be described as follows :

Head jet black, very shining, with a number of shallow punctures, in each of which is a very short yellowish hair. Mouth parts pitchy brown. Thorax shining, smooth, jet black, with two deep longitudinal grooves; scutellum less shining and deeply corrugated, as are also the sides and extreme anterior portion of the thorax. Antennæ testaceous, thirteen-jointed; first joint elongated, much thicker at the extreme end than at the base; second joint almost globular and about one-half as long as the first; third joint slender, longer than the first, becoming slightly thicker toward the apex; fourth to sixth joints about the same size and shorter than the third; the remaining joints are still somewhat smaller, but are about the same size ; last joint, bud-shaped. The antennæ are also sparsely covered with short yellowish hair. Body jet black, shining. Legs, testaceous. Two males. Length, 4 mm.

Types of gall and flies in Coll. Am. Mus. Nat. Hist.

Diastrophus cuscutæformis *Osten Sacken.*

PLATE X, FIG. 1.

Diastrophus cuscutæformis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 39, 45.

This gall infests the branches of the common Blackberry (*Rubus villosus*), and consists of globular, woody, seed-like bodies. They are pressed closely together, and each is provided with more or less spines. Not common.

Two specimens. Coll. Am. Mus. Nat. Hist.

Diastrophus nebulosus *Osten Sacken.*

PLATE X, FIG. 2.

Diastrophus nebulosus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, p. 36; RILEY, Am. Ent. Vol. II, p. 159; FULLER, Am. Ent. Vol. III, p. 63; SAUNDERS, Ins. Inj. Fruit, p. 318.

This large swelling is found on the canes of the Blackberry (*Rubus villosus*). It is about two or three inches long, and when immature is dark green, turning red or reddish brown as the season advances. It is oblong in form, with the surface somewhat uneven, with deep longitudinal furrows, which divide the gall more or less completely into four or five parts. Inside there are numerous oblong cells, each containing a single larva, which is about one-tenth of an inch long, white, with the mouth parts and the spiracles and an oval spot on each side behind the head of the same color. The perfect insect emerges in spring the following year. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Diastrophus potentillæ *Bassett.*

Diastrophus potentillæ BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 689.

Found on the axils of the leaves of *Potentilla canadensis.* In summer the gall is green, and when dry is of a spongy substance. Each gall contains a single cell. It is round or oblong in shape and measures about one-third of an inch in diameter. Not common. Taken at Fort Lee, N. J., Astoria, L. I., and Staten Island.

Amphibolips confluentus (*Harris*).

PLATE X, FIG. 4.

Cynips confluentus HARRIS, Rep. Ins. Inj. Veget. 1st Ed. 1841, p. 397.
Cynips confluens HARRIS, Rep. Ins. Inj. Veget. 2d Ed. 1852, p. 433; *ibid.* 3d Ed. 1862, p. 546; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 53; WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.
Cynips aciculata OSTEN SACKEN, Proc. Ent. Soc. Phil.Vol. I, p. 56, 245; *ibid.* Vol. IV, p. 354; WALSH, Proc. Ent. Soc. Phil. Vol. II, pp. 443, 462, 481; Am. Ent. Vol. II, p. 330; WALSH & RILEY, Am. Ent. Vol. I, p. 103.
Cynips coccineæ OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, pp. 243, 248; *ibid.* Vol. IV, p. 354; WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.
Amphibolips coccineæ ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 104.
Cynips spongifica OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, pp. 244, 248; *ibid.* Vol. IV, p. 347; WALSH, Proc. Ent. Soc. Phil. Vol. II, pp. 443, 452; Am. Ent. Vol. II, p. 330; WALSH & RILEY, Am. Ent. Vol. I, p. 103.
Amphibolips spongifica ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 104.

This well-known gall is very common in this vicinity, and makes its appearance early in May, as soon as the leaves put forth, on different kinds of oaks, belonging to the red oak group, and is fully grown in a few weeks. It is popularly known as 'Oak-apple' or 'May-apple,' owing to its resemblance to a small apple. The gall measures from one to two inches in diameter, and is more or less smooth and globular, sometimes slightly elongated. Inside it is filled with a spongy substance in the centre of which is a hard kernel containing the larval cell. When fresh the gall is a pale green, soft and succulent, with the contents whitish. But later in the season the shell becomes brown, hard and brittle, with the kernel woody and the spongy substance dark brown, but remaining soft.

From a certain number of these galls emerge, by the middle of June, both male and female gall-flies. These have been named by Osten Sacken, *Cynips* (*Amphibolips*) *spongifica*. The gall-flies which emerge in October or the following spring are all females, and have been named *Cynips* (*Amphibolips*) *aciculata* by the same author, but they have been proven by the late B. D. Walsh to be merely a dimorphous female of the former. *A. aciculata* and *A. spongifica* were supposed by Osten Sacken to be two different species and to occur on the Black Oak (*Quercus tinctoria*) only. I have, however, bred specimens of the autumnal form (*A. aciculata*) from galls which I found on Red Oak (*Quercus rubra*), Scarlet Oak (*Quercus coccinea*), Black Oak (*Quercus tinctoria*) and Black-jack Oak (*Quercus nigra*), which I am unable to separate from an authentic specimen of *A. aciculata* deposited in the Museum by Baron Osten Sacken some years ago. I have also examined Harris's type of *C. confluentus* in the collection of the Boston Society of Natural History, and find it to be identical with *A. aciculata* O. S., over which the name *A. confluentus* has precedence.

A. coccineæ O. S. was described from the gall only, and Walsh (Proc. Ent. Soc. Phil., Vol. II, p. 447), was certainly correct in uniting it with *A. spongifica*.

Amphibolips inanis (*Osten Sacken*).

Plate X, Fig. 5.

Callaspida confluens Fitch, 5th Rep. Nox. Ins. in Trans. N. Y. State Agricul. Soc. 1858, p. 817.
Cynips inanis Osten Sacken, Proc. Ent. Soc. Phil. Vol. I, p. 58, 242, and Vol. IV, p. 354; Walsh, Proc. Ent. Soc. Phil. Vol. II, p 457; Am. Ent. Vol. II, p. 331; Walsh & Riley, Am. Ent. Vol. I, p. 105.
Amphibolips inanis Ashmead, Trans. Am. Ent. Soc. Vol. XII, p. 294; Packard, 5th Rep. U. S. Ent. Com. p. 104.

The outside of this gall shows no difference from that of the preceding species, except in being considerably smaller. The internal structure, on the contrary, distinguishes it at once. Instead of being filled with the spongy substance, as in *A. confluentus* Harr., this gall is almost empty; the larval cell being kept in its central position by a certain number of whitish filaments which radiate from it to the shell. Found in May on the leaves of the Scarlet Oak (*Quercus coccinea*) and Red Oak (*Quercus rubra*). Not common. West Farms, N. Y., Fort Lee, N. J., and Staten Island.

Two examples. Coll. Am. Mus. Nat. Hist.

Amphibolips ilicifoliæ (*Bassett*).

PLATE X, FIG. 6.

Cynips ilicifoliæ BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 681.
Amphibolips ilicifoliæ ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Occurs on the leaf or petiole of *Quercus ilicifolia.* It is elongated and fusiform, tapering at both ends, with the apex somewhat longer and more slender than the basal portion, and is sometimes considerably curved. The gall is green or brownish, thin and brittle when dry, with an elongated kernel inside, held in position by radiating fibres. Rare in the vicinity of New York. Taken by W. T. Davis at Tottenville, S. I., and by the late Hy. Edwards at Vineland, N. J.

Three examples. Coll. Am. Mus. Nat. Hist.

Amphibolips prunus (*Walsh*).

Cynips prunus WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 639; WALSH & RILEY, Am. Ent., Vol. I, p. 104.
Amphibolips prunus ASHMEAD; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

In the latter part of August and early in September this gall may be found fully developed, and growing from one side of the acorn of the Red Oak (*Quercus rubra*) and Black Oak (*Quercus tinctoria*). It is globular, smooth, and fleshy, but is solid, and somewhat resembles a plum. Outside it is of a bright crimson and internally it is pinkish shading into yellow towards the middle. The larva lives singly in a cell in the centre of the gall, and the perfect insect emerges in May the following year. According to Walsh (Am. Ent., I, p. 104) it sometimes remains in the larva state for two years and does not eat its way out until the end of the third year. The gall measures from a half to one inch in diameter. Not rare in this vicinity. I have taken it in abundance at Fort Lee, N. J.

Andricus (Callirhytis) cornigerus (*Osten Sacken*).

PLATE X, FIG. 3.

Cynips cornigera OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 251, and Vol. IV, p. 358.
Andricus (*Callirhytis*) *cornigera* BASSETT, Am. Nat. Vol. XVI, p. 246.
Andricus (*Callirhytis*) *cornigerus* ASHMEAD, Trans, Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This is one of the most common galls found in the vicinity of New York City. It infests the branches of the Pin Oak (*Quercus palustris*) and is often found by the hundreds upon a single tree. The gall is irregularly rounded and is composed of a woody substance, with numerous horn-like protuberances, through which the gall-flies make their escape. Internally there are numerous cells, each containing a single larva. The perfect insect emerges from the gall early in spring. The gall also occurs on the Scrub Oak (*Quercus ilicifolia*) and Black-jack Oak (*Quercus nigra*), but very rarely.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) punctatus (*Bassett*).

Cynips punctata BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 324; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 358.
Andricus (*Callirhytis*) *punctata* BASSETT, Am. Nat. Vol. XVI, p. 246.
Andricus (*Callirhytis*) *punctatus* ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Closely allied to *Andricus cornigerus* O. S., but may be readily separated from this species by the absence of the horn-like protuberances. It is one of the most conspicuous galls, and by its abundance, wherever it occurs, it deforms the trees and does considerable injury. Sometimes the gall is found singly, but often a number of them may be seen, in more or less proximity, on the same twig. It is composed of a woody substance and internally there are a number of cells, as in *A cornigerus* O. S. I have taken the gall in abundance at Cold Spring Harbor, L. I., on the Black-jack Oak (*Q. nigra* L). It is also found on the Scarlet Oak (*Q. coccinea*), Red Oak (*Q. rubra*), and Scrub Oak (*Quercus ilicifolia*).

Two examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) seminator (*Harris*).

Cynips seminator HARRIS, Rep. Ins. Inj. Veget. 1st Edit. p. 399; FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 813; WALSH & RILEY, Am. Ent. Vol. I, p. 250, and Vol. II, p. 71.
Andricus seminator OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p 379.
Andricus (*Callirhytis*) *seminator* BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall is found in June growing on small twigs of the White Oak (*Quercus alba*). It is composed of a woolly substance, and is irregularly rounded. Inside are numerous seed-like bodies adhering around the twig, and very much resembling canary seeds. The gall is pure white or white tinged with red, but towards the middle of the summer assumes a rusty brown shade. It measures from one inch to about two inches and a half in diameter. Common.

Two examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) futilis (*Osten Sacken*).

PLATE XI, FIG. 1.

Cynips futilis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 63.
Andricus futilis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.
Andricus (*Callirhytis*) *futilis* BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall is a pale green, rounded, somewhat flattened, and projects on both sides of the leaf. Inside there are two or three seed-like, oblong kernels, kept in position by some whitish filaments. It appears early in May on the leaves of the White Oak (*Quercus alba*) and is fully grown about the middle of the month or early in June. The perfect insect emerges in the latter part of June or early in July, when the gall becomes dry and changes to a light brown color. Very common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) papillatus (*Osten Sacken*).

Cynips papillata OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 64, and Vol. IV, p. 352.
Andricus papillata OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.
Andricus (*Callirhytis*) *papillatus* ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Occurs in numbers on the same leaf on the Chestnut Oak (*Quercus prinus*). The gall is rounded and projects on both sides of the leaf; it is somewhat nipple-shaped, and is enclosed in a reddish aureola on the under side, which is very characteristic and by means of which it can be separated from the preceding species. Inside the gall are two or three kernels each containing a single larva. It is found in May and the perfect insect emerges in June. Probably this and the preceding species are the same, attacking two kinds of oaks. Not common.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) similis (*Bassett*).

PLATE XI, FIG. 2.

Cynips similis BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 685.
Andricus (*Callirhytis*) *similis* BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

In general appearance this gall very much resembles that of *C. tuber* Fitch, as does also the perfect insect, but, according to Mr. Bassett, it is evidently a different species. The gall is club-shaped and woody, growing at the ends of small limbs. The apex is blunt and generally turned to one side, covered in summer with a few leaves. The gall is rare in this vicinity and is found on *Quercus ilicifolia*. It has been taken by W. T. Davis at Tottenville, S. I., and by myself at Tom's River, N. J.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) clavula (*Bassett*).

PLATE XI, FIG. 3.

Cynips arbor FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 809; BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 686.
Cynips clavula BASSETT, Proc. Ent. Soc. Vol. IV, p. 351; OSTEN SACKEN, Proc. Ent. Soc. Vol. IV, p. 379.
Andricus (*Callirhytis*) *clavula* BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Forms a club-shaped gall at the tips of the twigs of the White Oak (*Quercus alba*). Early in summer it is green; in winter it is of the same color as the twig, and is very hard and woody. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) palustris (*Osten Sacken*).

Cynips palustris OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 62, and Vol. III, p. 359; Trans. Am. Ent. Soc. Vol. III, p. 54.
Andricus (*Callirhytis*) *palustris* BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

The shell of this gall is green and succulent. Inside it is hollow, with a small whitish globular body of about one-tenth of an inch in diameter, containing the larva, and rolls freely about, not being fastened to the shell. The gall is globular, measures about one-half inch in diameter, and occurs on the buds and young leaves of the Pin Oak (*Quercus palustris*) early in May. The perfect insect emerges about the middle of May. Very common in Central Park and at Astoria, L. I.

Andricus singularis (*Bassett*).

PLATE XI, FIG. 4.

Cynips singularis BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 326; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 355.
Andricus singularis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall may be found in the early part of June, infesting the leaves of the Red Oak (*Q. rubra*). It is smooth, thin, and varies in diameter from a quarter to one-half an inch. Each gall has an oblong cell in the centre, which is held in place by radiating fibres. There is seldom more than one gall on each leaf, although two and even three are occasionally met with. The gall reaches its full development with the leaf, and the perfect insect emerges in July. At first the gall is green and succulent, but turns brown and becomes brittle later in the season. In general appearance this gall resembles *Amphibolips inanis* O. S., but may be readily distinguished by its small size.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus petiolicola (*Bassett*).

PLATE XIII, FIG. 2.

Cynips petiolicola BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 325.
Andricus petiolicola OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379; BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall affects the petiole at the base of the leaf and sometimes also the mid-rib. It is found on the White Oak (*Quercus alba*), Chestnut Oak (*Quercus prinus*), Swamp White Oak (*Quercus bicolor*) and Post Oak (*Quercus obtusiloba*). It is rounded or club-shaped, and is of a woody texture; contains a number of cells. Early in the season it is green, but later becomes brown. Common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus lana (*Fitch*).

PLATE XI, FIG. 5.

Cynips lana FITCH, 5th Rep. Nox. Ins. Trans. N. Y. State Agricul. Soc. 1858, p. 814.
Andricus lana ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

The oak-wool gall is found upon the principal veins on the undersides of the leaves of the White Oak (*Quercus alba*). It very much resembles a small mass of wool, and is white or buff colored. Internally this mass is composed of numerous small seed-like capsules of a bright chestnut color, crowded together and attached by their lower ends to the vein of the leaf. Common.

Coll. Am. Mus. Nat. Hist.

Cynips (?) prinoides, n. sp.

PLATE XI, FIG. 6.

A number of galls of this species were collected by me at Tom's River, New Jersey, from the upper sides of the leaves of the Dwarf Chestnut Oak (*Quercus prinoides*) in the latter part of August and early in September. The gall is globular and about one-half inch in diameter, and is covered with numerous cone-like projections. When fresh it is light green tinged with red.

Inside is a single cell in which the larva lives. I did not succeed in raising any flies from the galls, but have found in cutting open one of them an apparently mature female specimen, which I describe as follows:

Sub-apterous; head, pitchy black, opaque, rugosely punctured; eyes also pitchy black, finely reticulated, and surrounded with a rather broad reddish brown ring. Antennæ black, thirteen jointed, with the first four joints elongated and about the same length; the remaining joints gradually decrease in size. Thorax dull reddish brown, darker in color at the sides, and deeply but finely punctate. Legs shining, reddish brown, with a few short yellowish hairs, which are also present on the head and thorax. Body jet black, very shiny; ovipositor with a few light-colored hairs. On the underside of the body, a little beyond the middle and in close proximity, are two bunches of rather long yellowish hairs. A few very short hairs of the same color are also present on the underside of the body at the base. Length, 3.5 mm.

I place the species only provisionally in the genus *Cynips.*

Cynips strobilana *Osten Sacken.*

PLATE XII, FIG. 6.

Cynips strobilana OSTEN SACKEN, Proc. Ent. Soc. Phil. I, p. 254; BASSETT, Proc. Ent, Soc. Phil. III, p. 690; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295.

This gall consists of a number of wedge-shaped bodies, closely packed together, with their pointed bases attached to a common centre. These wedges are hard and corky, and break off very easily when the gall is dry. Each of them contains a hollow kernel with a plump larva inside. According to Osten Sacken this gall is evidently produced by the sting of the insect on the single leaves of a bud, each leaf growing into the shape of a wedge. It occurs on the tip of the twigs of the Swamp Oak (*Q. bicolor*), and is rare in this neighborhood.

One specimen. Coll. Am. Mus. Nat. Hist.

Cynips pisum *Fitch.*

Cynips pisum FITCH, 5th Rep. Nox. Ins. N. Y. Trans. N. Y. Agri. Soc. XVIII, p. 818; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 59; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 303.

Common on the veins of the upper or underside of the leaves of the White Oak (*Q. alba*). The gall is about the size of a pea, which it very much resembles in general appearance. Its surface is finely nettled with fissures or cracks and intervening elevated points, like the surface of a strawberry. Inside there are usually two cavities divided in the centre by a thin partition. The gall is pale greenish yellow tinged on one side with red. It may be found fully developed in June and July.

Several examples. Coll. Am. Mus. Nat. Hist.

Acraspis erinacei (*Walsh*).

PLATE XII, FIG. 1.

Cynips erinacei WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 483.
Acraspis erinacei MAYR, Genera der Gallbew. Cynipid. p. 29; BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall appears in June and July on the leaves of the White Oak (*Quercus alba*), and is fully developed in August and September. It is attached by a single point to the leaf, and generally grows on one of the principal veins on the upperside. When fully grown the gall is rounded and is finely netted with fissures and covered with rather long spines. It is yellow or greenish yellow with the spines bright red, especially so when young.

Six specimens. Coll. Am. Mus. Nat. Hist.

Biorhiza forticornis (*Walsh*).

PLATE XIII, FIG. 3.

Cynips ficus FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 812; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 368.
Cynips (*Biorhiza*) *forticornis* WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 490.
Teras forticornis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.
Acraspis forticornis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

These galls occur in a dense cluster around the young twigs or tender shoots of the White Oak, and each is moulded to the shape of those pressing against its sides, and somewhat resembles preserved figs packed in boxes, hence the name 'Fig-gall.' The gall is soft, bladder-like, and inside contains a single cell, held in place by radiating fibres. It is pale yellow, often beautifully tinged with bright red. In winter the gall is of the color of a faded oak leaf. It is fully grown in August. The gall and guest-fly have been named by Fitch *Cynips ficus*. But the true gall-maker was discovered later by Walsh who named the species *Biorhiza forticornis*.

Several examples. Coll. Am. Mus. Nat. Hist.

Biorhiza hirta (*Bassett*).

Cynips hirta BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 688 ; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 353.
Teras hirta OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.
Biorhiza hirta ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296 ; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall measures about one-quarter of an inch in diameter. It is hard, round, with a fine papillose surface and a solid radiating cellular structure. It usually grows on the underside of the leaf attached to one of the larger veins by a very short pedicel, but is also sometimes found on the upperside. It is very rare in this vicinity and is found on Rock Chestnut Oak (*Q. monticola*). A single specimen, so named, is in the Museum collection from West Point, N. Y., collected by Baron Osten Sacken.

Holcaspis globulus (*Fitch*).

PLATE XII, FIG. 4.

Callaspidia globulus FITCH, 5th Rep. Nox. Ins. N. Y. State Agricul. Soc. 1858, p. 811 ; PACKARD, 5th Rep. U. S. Ent. Com. p. 111.
Cynips globulus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 67 ; BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 328.
Holcaspis globulus MAYR, Genera der Gallbew. Cynipid. p. 35 ; BASSETT, Am. Nat. Vol. XVI, p. 246; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

These bullet-like galls are common on the White Oak (*Quercus alba*), and grow singly or in clusters of two, three or more on the terminal twigs. Internally the gall is of a corky texture and contains in its centre a single worm, lying in an oval, whitish shell, resembling a minute egg. In summer the gall is yellow or tinged with red, and when the colder weather sets in it turns brown. The gall is also found on the Post Oak (*Quercus obtusiloba*) and Chestnut Oak (*Quercus prinus*).

Several examples. Coll. Am. Mus. Nat. Hist.

Holcaspis duricoria *Bassett.*

PLATE XII, FIG. 5.

Holcaspis duricoria BASSETT, Trans. Am. Ent. Soc. Vol. XVII, p. 64; Am. Nat. Vol. XVI, p. 246.

Somewhat resembles the gall of *H. globulus* Fitch, but may be readily distinguished by being much rougher outside and less regularly globular, with the base flattened and the apex extended into a cone-like process. Internally the substance is similar, but much harder than that of *H. globulus*. It also contains a free larval cell. Occurs on the Swamp Oak (*Q. bicolor*). Rare in the vicinity of New York.

A few specimens. Coll. Am. Mus. Nat. Hist.

Dryophanta polita (*Bassett*).

PLATE XII, FIG. 3.

Cynips polita BASSETT, Can. Ent. Vol. XIII, p. 99.
Dryophanta polita BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall is globular, and is found in August and September on both surfaces of the leaves of the Post Oak (*Quercus obtusiloba*) at or near the summit of young and thrifty shoots, from one to twenty occurring on a single leaf. It is one-quarter to three-quarters of an inch in diameter, and pale green, but when exposed to the sun becomes red or reddish brown. When dry the shell is very thin and brittle, and contains a single round larval cell, held in a central position by radiating branching fibres which extend to the outer shell. The perfect insect, according to Mr. Bassett, becomes mature in October but remains in the gall over winter.

Common at Tom's River, New Jersey. Taken by Mr. W. T. Davis and myself.

One fine example. Coll. Am. Mus. Nat. Hist.

Neuroterus batatus (*Fitch*).

PLATE XIII, FIG. 1.

Cynips batatus FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 810; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 71; BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 684.
Neuroterus batatus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Abundant, especially on the branches of young trees. The gall is generally large and uneven, and often resembles a potato in shape. It is hard and woody, with the surface coated with a glaucous, pale bluish bloom. Internally it is of a dense corky texture with numerous larval cells. The gall grows on the White Oak below the terminal shoot, and is sometimes quite injurious by deforming the young twigs of the tree.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Neuroterus noxiosus (*Bassett*).

Cynips noxiosa BASSETT, Can. Ent. Vol. XIII, p. 108.
Neuroterus noxiosus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Found on the terminal twigs of the Swamp White Oak (*Quercus bicolor*). It very much resembles that of *Neuroterus batatus* in shape and size. But according to Mr. Bassett the flies that produce this gall are distinct. Taken by me in Central Park. Rare. Two type specimens of the summer form and three of the winter form were given to the Museum by Mr. H. F. Bassett.

Neuroterus floccosus (*Bassett*).

PLATE XII, FIG. 2.

Cynips floccosa BASSETT, Can. Ent. Vol. XIII, p. 111.
Neuroterus floccosus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Very common on the under surface of the terminal leaves of the Swamp Oak (*Quercus bicolor*). Sometimes as many as two hundred galls are often found upon a single leaf, and which cause the leaf to become deformed and to curl up. The gall is hemispherical and covered with white hairs. On the upperside of the leaf its position is indicated by a small, smooth, shining blister-like elevation. I have found the gall fully grown in July, and others in various stages of growth, as well as the perfect insect ovipositing.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Neuroterus umbilicatus *Bassett, MS.*

Occurs in considerable numbers on the underside of the leaves of the Swamp White Oak (*Quercus bicolor*). The gall is rounded, much depressed, with a deep circular cavity on top, in the centre of which is a small nipple. It is brown, and measures about one-tenth of an inch in diameter. Its position is indicated on the upper surface of the leaf by a circular spot. Taken by me on Staten Island. Not rare.

Three type specimens were kindly presented to the Museum by Mr. H. F. Bassett.

Aulax tumidus *Bassett.*

Aulax tumidus BASSETT, Trans. Am. Ent. Soc. Vol. XVII, p. 92.

This gall forms a thick swelling on the main stalk of Wild Lettuce (*Lactuca*). It is usually found near the summit of the stalk, often in the panicle itself and then covered with the short flower stems. The gall varies greatly in size from a slight, knotty and irregular enlargement of the stalk to a large and more or less ovate swelling, two or three inches long and an inch in diameter. The larvæ are imbedded in the soft pitchy matter which fills the gall.

Two specimens. Coll. Am. Mus. Nat. Hist.

TENTHRENIDÆ.

Nematus pomum *Walsh.*

Nematus pomum WALSH, Proc. Ent. Soc. Phil. Vol. VI, p. 255; WALSH & RILEY, Am. Ent. Vol. II, p. 45 (fig.).

Found on several species of bush Willows (*Salix*). It makes its appearance early in spring and is fully matured in July and August. The gall is yellowish green, usually with a rosy cheek, and measures about one-half inch in diameter. It is rounded and somewhat resembles a miniature apple. Common.

Euura ovum *Walsh.*

Euura ovum WALSH, Proc. Ent. Soc. Phil. Vol. VI, p. 251; WALSH & RILEY, Am. Ent. Vol. II, p. 49 (fig.).

This gall is found on the stems of the Willow (*Salix*), and is an oval or elongated swelling, about one-half an inch long, placed lengthwise on one side of the twig. Not common.

DIPTERA.

CECIDOMYIDÆ.

Cecidomyia serrulatæ *Osten Sacken.*

PLATE XIII, FIG. 4.

Cecidomyia serrulatæ OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 198.

The gall is a deformation of the terminal bud of the common Alder (*Alnus serrulata*), which appears enlarged and rounded, with the apex pointed. In autumn it is greenish; in winter, brown, and often covered with a whitish efflorescense. Each gall contains from two to six reddish larvæ, which leave the gall late in fall to complete their transformation in the earth. The fly emerges the following spring. Common at Ravenwood, Long Island, and Mosholu, N. Y.

Six specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia verrucicola *Osten Sacken.*

Cecidomyia verrucicola OSTEN SACKEN, Can. Ent. Vol. VII, p. 200.

This gall is found in July and August on the leaves of the Linden (*Tilia americana*). It occurs in numbers upon the same leaf, and is wart-shaped, round, pale green, and measures about one-fifth of an inch in diameter. In autumn the gall becomes brown, hard and woody, and springs open on the underside, a circular piece detaching itself and either falling to the ground or remaining fastened to the gall at one edge, in the shape of a lid.

Taken by me near Yonkers, N. Y., and by Baron Osten Sacken, near West Point, N. Y.

Cecidomyia tulipiferæ *Osten Sacken.*

Cecidomyia tulipifera OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202.

Taken by me at Short Hills, New Jersey, on the Tulip-tree (*Liriodendron tulipifera*). The gall infests the mid-rib of the leaf, and is a small rounded swelling. Rare.

Cecidomyia liriodendri *Osten Sacken.*

Cecidomyia liriodendri OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202.

Forms brown spots with a yellow or greenish aureole on the leaves of the Tulip-tree. These spots are about one-third of an inch in diameter, and a number of them may be found upon a single leaf. Common.

Several specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia cerasi-serotinæ *Osten Sacken.*

Cecidomyia cerasi-serotinæ OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, p. 346.

The gall is an enlargement of the terminal bud of young shoots of the Wild Cherry (*Prunus serotina*), and makes its appearance in May. It is bright red, more or less rounded, with one or two leaves growing from its sides. The consistency of the gall when young is fleshy; the cavity on the inside occupies about one-half of the diameter of the gall and is filled with bright yellow larvæ, which, according to Osten Sacken (l. c., p. 347) have the power of leaping by the contraction of their bodies. Found in Tarrytown, N. Y., by Osten Sacken. I have also taken it in Central Park, New York City. Rare.

Cecidomyia pellex *Osten Sacken.*

Cecidomyia pellex OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199.

Taken at Fort Lee, New Jersey, in June, on the Ash (*Fraxinus americana*). The gall occurs on the ribs of the leaf, is rounded oblong on the upperside, and on the underside it is indicated by the surface being somewhat swollen. It is pale green, succulent, subpellucid, and sometimes is tinged with brown.

Cecidomyia gleditschiæ *Osten Sacken.*

Cecidomyia gleditschiæ OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. VI, p. 219.

Taken in Central Park, New York City, in June and July, on the leaves of the Honey-locust (*Gleditschia triacanthos*). The gall is formed of a single leaflet, folded in such a way as to assume the shape of a pod. Sometimes nearly all the leaves on the terminal twigs are deformed in this way. The fly completes its transformations within the gall and emerges in July and August.

Five examples. Coll. Am. Mus. Nat. Hist.

Cecidomyia holotricha *Osten Sacken.*

PLATE XIV, FIG. 1.

Cecidomyia holotricha OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 193; GLOVER, MS. Notes from my Journ. pl. xi, fig. 23.

This gall may be found through the summer on the underside of the leaves of the Shell-bark Hickory (*Hickoria ovata*), and also all other kinds of Hickories. Sometimes they cover the entire under surface of the leaf, which becomes deformed and gradually shrivels up from the injury done by the galls. The gall is subglobular, onion-shaped, and covered with a pubescence which is pale when the gall is young and growing, and becomes rust-colored when mature. It is hollow, and contains a single larva. Abundant everywhere in this vicinity.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia caryæcola *Osten Sacken.*

PLATE XIV, FIG. 2.

Cecidomyia caryæcola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192; GLOVER, MS. Notes from my Journ. Dipt. pl. xi, fig. 24.

Pale green, smooth, elongated, onion-shaped, with the tip prolonged into a point. Found in clusters on the undersides of the leaves of different kinds of Hickories. Common.

Several examples. Coll. Am. Mus. Nat. Hist.

Cecidomyia tubicola *Osten Sacken.*

PLATE XIV, FIG. 4.

Cecidomyia tubicola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192; GLOVER, MS. Notes from my Journ. Dipt. pl. xi, fig 25.

These narrow, cylindrical, tube-like galls infest the underside of the leaves of different kinds of Hickories. They are inserted in a small protuberance on the leaf and break off very easily. When immature they are green, and when ripe they are blackish brown. Very common.

Four specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia sanguinolenta *Osten Sacken.*

Cecidomyia sanguinolenta OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192.

This gall occurs in numerous clusters on the leaves of different species of Hickories. It is conical, somewhat narrowed at the base, and is of a blood-red or purplish color. Not common; at Fort Lee, N. J., in July.

Cecidomyia persicoides *Osten Sacken.*

PLATE XIV, FIG. 3.

Cecidomyia persicoides OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 193.

These curious excrescences are found on the underside of the leaves of different kinds of Hickories. The galls are variable in size and shape and are clothed with a delicate down like that of a peach, and look like a very diminutive fruit of this kind. Sometimes the galls grow along the mid-rib from one end to the other; they then assume irregular shapes and entirely deform the leaf. They may be found fully developed in August. Common.

Three examples. Coll. Am. Mus. Nat. Hist.

Cecidomyia strobiloides *Osten Sacken.*

PLATE XV, FIG. 1.

Cecidomyia strobiloides OSTEN SACKEN, Mon. Dipt. pt. I, p. 203; WALSH & RILEY, Am. Ent. Vol. I, p. 105; PACKARD, Guide to Study of Insects, p. 377; GLOVER, MS. Notes from my Journ. pl. xi, fig. 15.

Found plentifully in different localities in this vicinity, on the terminal twigs of various kinds of low Willows; it is formed of closely imbricated leaves, assuming the shape of a cone. The gall makes its appearance in April and May and is fully grown in July.

Several examples. Coll. Am. Mus. Nat. Hist.

Cecidomyia brassicoides *Walsh.*

Cecidomyia brassicoides WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 577; WALSH & RILEY, Am. Ent. Vol. I, p. 105; PACKARD, Guide to Study of Insects, p. 377.

Found on Willow (*Salix longifolia*). The gall infests the tips of the twigs and consist of a more or less close-set bunch of leaves. The larva and perfect insect were described by Walsh (l. c.). Not common.

Cecidomyia rigidæ *Osten Sacken.*

PLATE XV, FIG. 2.

Cecidomyia salicis FITCH, Journ. Agricul. & Sc. Vol. I, p. 263 (*name preoc.*).
Cecidomyia rigidæ OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 189.
Cecidomyia siligua WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 591; RILEY, Am. Ent. Vol. II, p. 214; GLOVER, MS. Notes from my Journ. pl. xi, fig. 19.

This gall grows on the tips of the twigs of different kinds of Willows. It is a woody, elongated swelling, tapering to a point at the apex, and with a number of small terminal buds growing from it. It contains a single larva, which channels the gall from one end to the other. Common, especially on *Salix discolor*.

Six specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia batatas *Walsh.*

Cecidomyia batatas WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 601.

The gall of this species infests the branches of the Willow (*Salix discolor*) and other species of Willow belonging to this group. It is hard and woody and varies considerably in size and shape; sometimes the different forms are strung together, one after the other, in more or less close proximity on the same twig. The shape of the gall is usually hemispherical, or irregularly ovate. Internally are numerous cells with orange-colored larvæ, which may be found from July to about March. Not common.

Four specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia clavula, n. sp.

PLATE XV, FIG. 5.

Found on the terminal twigs of the Dog-wood (*Cornus florida*). The gall is a club-shaped swelling about an inch long. Inside is an elongated channel, which is inhabited by a single orange-colored larva. In July I have taken this gall with the larva nearly fully grown, but did not succeed in raising it. The gall is very common on Staten Island. Also taken at Nyack, N. Y., by Rev. J. L. Zabriskie, who informs me that he also failed to rear the insect. In summer the gall is green and in winter it assumes the color of the bark of the twig.

Eight specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia impatientis *Osten Sacken.*

Cecidomyia impatientis OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 204; GLOVER, MS. Notes from my Journ. pl. xi, fig. 16.

Produces a round, succulent swelling at the base of the flower of *Impatiens fulva* in August. The gall is green, semitransparent and contains a number of cells inside. Not common. Taken at Mosholu, N. Y.

Cecidomyia sambuci-umbellicola *Osten Sacken.*

Cecidomyia sambuci-umbellicola OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, pp. 52, 347.

Taken by Osten Sacken near South Orange, N. J., and at Tarrytown, N. Y., in June among the umbels of the common Elder (*Sambucus canadensis*). The gall is an enlargement of the buds of the flowerlets, and inside of each such bud is an orange larva. The perfect insect is unknown.

Cecidomyia pilulæ (*Walsh*).

PLATE XV, FIG. 3.

Cynips pilulæ WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.
Cecidomyia pilulæ WALSH & RILEY, Am. Ent. Vol. II, p. 29; RILEY, 5th Rep. U. S. Com. p. 206.

This gall is often so abundant that almost every leaf of the tree bears at least from five to seventy-five or more individuals.

and sometimes nearly all the leaves are studded with them. In the vicinity of New York it chiefly occurs on the Pin Oak (*Quercus palustris*) and Red Oak (*Quercus rubra*); but is also found on the Black-jack Oak (*Quercus nigra*), Scrub Oak (*Quercus ilicifolia*) and other species belonging to the Red Oak group. The gall when ripe is fleshy, but still solid, and when dry it is very hard and woody. Inside there are several cells inhabited by bright orange-red larvæ. The gall makes its appearance in May before the leaves are fully developed; it is then blister-like, yellow or pale brown, and is surrounded by a light green ring. When fully developed in August and September it is bright red or reddish brown. The gall varies greatly in size, shape and color. On the Red Oak, Scarlet Oak, and Black Oak (*Q. rubra*, *Q. coccinea* and *Q. tinctoria*) it is usually quite small, rounded and deep red, while on the Pin Oak (*Q. palustris*) it is much larger, greenish in color and looks almost like a different gall. On the Scrub Oak (*Q. ilicifolia*) the gall resembles that on Red Oak, but is much lighter in color. Frequently two or more galls are confluent and assume a very irregularly rounded or elongated form. The differences in appearance in this gall is accounted for by the behavior of the gall on different kinds of Oaks. On the under surface of the leaf the gall is indicated by a green nipple.

Cecidomyia symmetrica O. S., an authentic specimen of which I have before me, differs only from *C. pilulæ* by protruding symmetrically on both sides of the leaf, and probably after the gall maker is known will have to be referred to this species; for the present, however, it must stand as distinct until we have further knowledge on the subject. *Cecidomyia symmetrica* is, as far as I can ascertain, only found on the Spanish Oak (*Quercus falcata*), and has not yet been found in the vicinity of New York. It was described from the vicinity of Washington, D. C., by Osten Sacken (Mon. Dipt. N. Am., pt. I, p. 200), who also mentions *C. pilulæ*, but characterizes *C. symmetrica* as the species.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia poculum *Osten Sacken.*

PLATE XV, FIG. 4.

Cecidomyia poculum OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 201; GLOVER, MS. Notes from my Journ. pl. xi. fig. 27.

The so-called Oak Spangles (*C. poculum*) are saucer-like outgrowths, which may be found in the latter part of the summer on the undersides of the leaves of the White Oak (*Quercus alba*), and, according to Osten Sacken, also on the Post Oak (*Quercus obtusiloba*). They vary in color from pale reddish to a light lavender, and generally occur in clusters, sometimes nearly covering the entire underside of the leaf. No insect has as yet been raised from the Oak Spangles in this country. Common.

Ten specimens. Coll. Am. Mus. Nat. Hist.

Cecidomyia niveipila *Osten Sacken.*

Cecidomyia niveipila OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199.

Collected by me at Watchogue, Staten Island, in May, on the young leaves of the Red Oak (*Quercus rubra*). The gall consists of a large fold lined with a white pubescence on the inside. Sometimes the entire leaf is folded with the edges curled up, the underside of the leaf being the inside of the gall. I have found as many as fifteen larvæ in a single gall. The perfect insect is not known. Not common.

Cecidomyia solidaginis *Loew.*

Cecidomyia solidaginis LOEW, Mon. Dipt. N. Am. pt. I, p. 194; GLOVER, MS. Notes from my Journ. pl. XII, fig. 32.

Infests the Golden-rod (*Solidago*), and is produced by the arrest of the stalk, which causes the leaves to accumulate, thus forming a globular bunch, consisting of several hundred leaves. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Cecidomyia carbonifera *Osten Sacken.*

Cecidomyia carbonifera OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 195; GLOVER, MS. Notes from my Journ. XII, pl. 29, fig. 27.

Found in August on the leaves of Golden-rod (*Solidago*). The gall is a pale yellowish brown circular spot, surrounded by a blackish ring. The perfect insect is unknown. Common.

Cecidomyia anthophila *Osten Sacken.*

Cecidomyia anthophila OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 302.

Taken in September, 1867, near Brooklyn, L. I., by Baron Osten Sacken, among the racemes of Golden-rod (*Solidago*). The gall is elongated-conical, blunt at the end and about one-third of an inch long. The surface is pale green, covered with a white down. Inside the gall is hollow and divided in two compartments by a delicate, somewhat funnel-shaped membrane, placed between about the middle of the cavity, point upward. The larva may be found at the bottom of the lower compartment.

Cecidomyia viticola *Osten Sacken.*

Cecidomyia viticola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202; WALSH, Am. Ent. Vol. II, p. 28; RILEY, 5th Rep. Nox. Ins. Mo. p. 119; SAUNDERS, Ins. Inj. Fruit, p. 292.

This gall is green or bright red, and narrow-elongate or conical in shape. It grows in numbers on the upper or lower side of the leaves of various kinds of Wild Grapes. Taken at Yonkers, N. Y., in July and August.

Cecidomyia vitis-pomum *Walsh & Riley.*

Cecidomyia vitis-pomum WALSH & RILEY, Am. Ent. Vol. I, p. 106 (fig.); RILEY, 5th Rep. Nox. Ins. Mo. p. 114; PACKARD, Guide to Study of Insects, p. 378; SAUNDERS, Ins. Inj. Fruit, p. 296; GLOVER, MS. Notes from my Journ. pl. xi, fig. 17.

This gall grows on the stems of the Wild Grape, and is variable in size and shape; it is usually rounded, flattened at the base and pointed at the tip. When mature, it often has eight or nine longitudinal ribs as in a musk-melon, and is much smoother than when young. Inside are numerous longitudinal cells which are divided by a transverse partition. Not common.

Lasioptera vitis *Osten Sacken.*

Lasioptera vitis OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202; RILEY, 5th Rep. Nox. Ins. Mo. p. 117 (fig.).

Found on stems and leaf-stalks of the Wild Grape (*Vitis cordifolia*). The gall consists of a bunch of irregular swellings of various rounded shapes. The substance of the gall is soft, juicy, translucent; color yellowish green tinged with red or entirely of this color. Taken at Parkville, L. I., in June.

Lasioptera farinosa *Osten Sacken.*

Lasioptera farinosa OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 204.

Produces a small, rounded woody swelling at the base of the leaflets or on the mid-rib of the common Blackberry (*Rubus villosus*). Not common.

Asphondylia monacha *Osten Sacken.*

Asphondylia monacha OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 299.

Collected in September, 1867, near Brooklyn, L. I., on *Solidago altissima*, by Baron Osten Sacken, according to whom this gall is like that of *Cecidomyia solidaginis*, consisting of an accumulation of leaves upon a stem or branch, the growth of which has been stunted by the operation of the insect. But it may be separated from it by difference in the inner structure. The leaves forming the inner part of the gall of *A. monacha*, although stunted in their growth, have none of the characteristic appearance of the numerous narrow ribbon-like leaves surrounding the central cell in the gall of *Cecidomyia solidaginis*. (See Mon. Dipt. N. Am., Loew, pt. I. pl. i, figs. 9 and 10.)

Asphondylia rudbeckiæ-conspicua *Osten Sacken.*

Asphondylia rudbeckiæ-conspicua OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, p. 51.

Taken at Mosholu, N. Y., in the latter part of July on the flower-heads of the Ox-eye Daisy (*Rudbeckia hirta*). Rare.

Sciara ocellaris (*Osten Sacken*).

Cecidomyia ocellaris OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199; GLOVER, MS. Notes from my Journ. pl. xi, fig. 29.
Sciara ocellaris COMSTOCK, Rep. U. S. Dept. Agricul. 1881, p. 202.

Common on the leaves of the Red Maple (*Acer rubrum*). The gall is an eye-like, circular spot, light yellow in color with a red central dot. Sometimes it is entirely green or yellow. The perfect insect and earlier stages were described and figured by Prof. Comstock (l. c.). Common.

Two specimens. Coll. Am. Mus. Nat. Hist.

TRYPETIDÆ.

Trypeta polita *Loew.*

Trypeta polita LOEW, OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 301.

The gall of this species is very common on *Solidago altissima* and other species of Golden-rods. It is caused by the arrest of the side branches and consists of a small bunch of accumulated, aborted leaves. Inside, at the base of the gall, is a hollow space in which the larva lives. The gall is a little over half an inch long, and sometimes as many as twenty-five occupy the end of the stalk.

Trypeta solidaginis (*Fitch*).

PLATE XV, FIG. 6.

Acinia solidaginis FITCH, 1st Rep. Nox. Ins. Trans. N. Y. State Agricul. Soc. Vol. XIV, p. 771.
Trypeta solidaginis LOEW, Mon. Dipt. N. Am. p. 82; GLOVER, MS. Notes from my Journ. pl. xl, fig. 33.

This species produces a round gall on the stalk of the Golden-rod (*Solidago*). Inside it is of a pithy substance, in the centre of which the larva lives in a round cell. The gall is fully developed in August. Common.

Several specimens. Coll. Am. Mus. Nat. Hist.

HEMIPTERA.

PSYLLIDÆ.

Pachypsylla venusta *Osten Sacken.*

PLATE XVI, FIG. 1.

Pachypsylla venusta OSTEN SACKEN, Stett. Ent. Zeit. 1861, p. 422; RILEY, 5th Rep. U. S. Ent. Com. p. 617 (fig.); Can. Ent. Vol. XV, p. 158.

Generally globular, but often more or less irregularly ovoid and very variable in size. The gall occurs on the petiole of the leaf of the Hackberry (*Celtis occidentalis*), and consists of an outer shell and an inner core which can be easily separated upon cutting the gall open. The apical portion of the gall has on one side a slit which is deepest and widest at the tip. The inner core consists of thin brittle walls of the irregular cells which fill the inside of the outer shell. Taken by me near Peekskill, N. Y. Rare.

One specimen. Coll. Am. Mus. Nat. Hist.

Pachypsylla celtidis-gemma *Riley.*

PLATE XVI, FIG. 3.

Pachypsylla celtidis-gemma RILEY, 5th Rep. U. S. Ent. Com. p. 618.

This gall occurs on the branches of the Hackberry (*Celtis occidentalis*), and is a deformation of the young bud which would form a new twig the ensuing year. It is variable in size and of irregular shape, but always bud-like and looking as if formed by the conglomeration of a number of rounded nodules. The gall is hard and woody with a number of cells inside. Common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Pachypsylla celtidis-vesiculum *Riley.*

Pachypsylla celtidis-vesiculum RILEY, 5th Rep. U. S. Ent. Com. p. 618.

This gall appears on the upperside of the leaf merely as a flat, rounded blister of a yellowish or greenish color. On the underside, when fully grown, it is somewhat convex, with a small nipple in the center. The galls often occur in large numbers on the same leaf. Very common on the Hackberry (*Celtis occidentalis*).

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Pachypsylla celtidis-mamma *Riley.*

Pachypsylla celtidis-mamma RILEY, Johnson's Universal Encylopedia, 1876; Can. Ent. Vol. XV, p. 158; 5th Rep. U. S. Ent. Com. p. 620 (fig.); FLETCHER, Rep. Ent. Soc. 1882, p. 79, 80.

Found on the leaves of the Hackberry (*Celtis occidentalis*). The gall on the upperside of the leaf is represented by a cup-shaped impression and on the underside is about 7 mm. high and about 5 mm. wide. In shape the gall is subcylindrical, with the apex bluntly rounded. Very common.

Several examples. Coll. Am. Mus. Nat. Hist.

Pachypsylla celtidis-cucurbita *Riley.*

PLATE XVI, FIG. 2.

Pachypsylla celtidis-cucurbita RILEY, 5th Rep. U. S. Ent. Com. p. 621.

Very common in various localities in this vicinity on the leaves of the Hackberry (*Celtis occidentalis*). On the upperside of the leaf the gall forms a cup-shaped impression and on the underside a rounded swelling, truncated at the top and concave in the center at the apex with a very small nipple. Around the top of the gall there is usually an acute rim which surrounds the concave depression, and at the sides near the top is furnished with short ribs, which are sometimes nearly obliterated.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

APHIDÆ.

Hormaphis hamamelidis *Fitch.*

PLATE XVI, FIG. 5.

Brysocrypta hamamelidis FITCH, 4th Rep. State Cab. Nat. Hist. N. Y. p. 69.

Produces a conical gall on the upperside of the leaf of the Witch Hazel (*Hamamelis virginica*). Very common.

Hormaphis spinosus (*Shimer*).

PLATE XVI, FIG. 4.

Hamamelistes spinosus SHIMER, Trans. Am. Soc. Vol. I, p. 284.
Hormaphis spinosus RILEY, Bull. U. S. Geo. Sur. (Hayden), Vol. V, p. 14; THOMAS, 3d Rep. Nox. Ins. Illinois, p. 207.

This gall is a deformation of the fruit-bud of the Witch Hazel (*Hamamelis virginica*) and is covered with a number of rather long spines. It is green and has at the base a funnel-like exit. Central Park, N. Y. City, in July and August. Not common.

Four examples. Coll. Am. Mus. Nat. Hist.

Colopha ulmicola (*Fitch*).

Byrsocrypta ulmicola FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 843.
Thelaxes ulmicola WALSH, Proc. Ent. Soc. Phil. Vol. I, p. 305; Am. Ent. Vol. I, p. 108.
Colopha ulmicola MONELL, Can. Ent. Vol. IX, p. 102.
Glyphina ulmicola THOMAS, 3d Rep. Nox. Ins. Ill. p. 142.
Colopha ulmicola RILEY, Bull. U. S. Geo. Sur. (Hayden), Vol. V, p. 9.

This species forms a cock's-comb-like gall on the upperside of the leaves of the White Elm (*Ulmus americana*) in June when the leaves are yet young. Common.

Pemphigus rhois *Fitch.*

PLATE XVI, FIG. 6.

Pemphigus rhois WALSH, Am. Ent. Vol. I, p. 108; THOMAS, 3d Rep. Nox. Ins. Ill. p. 152; PACKARD, Guide to Study of Insects, p. 524.

The gall of this species occurs on the underside of the leaves of the Smooth Sumac (*Rhus glabra*) and Staghorn Sumac (*Rhus typhina*). It somewhat resembles a tomato in shape, and is of a yellowish green color tinged with red. It is fully grown in August, and the insects inside are fully developed in September. Common.

Two examples. Coll. Am. Mus. Nat. Hist.

Pemphigus populicaulis *Fitch.*

Pemphigus populicaulis FITCH, 5th Rep. Nox. Ins. N. Y. Trans. Agricul. Soc. 1858, 845; LEBARON, 3d Rep. Nox. Ins. Ill. 1873, p. 193; THOMAS, 3d Rep. Nox. Ins. Ill. (Trans. Dept. Agricul. 1878), p. 149; WALSH & RILEY, Am. Ent. Vol. I, 2d Ser. 1880, p. 206; PACKARD, 5th Rep. U. S. Ent. Com. p. 471.

This species forms an irregularly rounded, green gall, at the junction of the stem and leaf of the Poplar (*Populus monilifera*). On the underside the gall is provided with a mouth-like orifice. Common at Passaic, N. J.

Phylloxera caryæcaulis (*Fitch*).

Pemphigus caryæcaulis FITCH, 1st Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1854, p. 859.
Phylloxera caryæcaulis THOMAS, 3d Rep. Nox. Ins. Illinois, p. 106; PACKARD, 5th Rep. U. S. Ent. Com. p. 322.

This species is found upon the twigs and leaf-stalks of different kinds of Hickories. It forms a hollow, green, bullet-like gall of a leathery texture. When fully grown it opens and becomes cup-shaped. The gall makes it appearance in May and early in June. Very common.

ARACHNIDA.

Acarus serotinæ, n. sp. (?)

PLATE XVI, FIG. 7.

This gall is produced by a mite (*Acarus*) and is probably undescribed. It occurs on the upperside of the leaves of the Wild Cherry (*Prunus serotina*) and is quite common in this neighborhood. The gall is about two-fifths of an inch long, and is a stem-like tube which expands into a pouch-like sac at the end. It is hollow, with an exit on the underside of the leaf. I name it provisionally *Acarus serotinæ.*

Several examples. Coll. Am. Mus. Nat. Hist.

EXPLANATION OF PLATES.

PLATE IX.

Fig. 1. Rhodites bicolor (*Harr.*).
" *2.* " ignota *O. S.*
" *3.* " radicum *O. S.*
" *4.* " globulus *Beut.*
Fig. 5. Rhodites dichlocerus (*Harr.*).
" *6.* " verna *O. S.*
" *7.* Diastrophus bassettii *Beut.*

PLATE X.

Fig. 1. Diastrophus cuscutæformis *O. S.*
" *2.* " nebulosus *O. S.*
" *3.* Andricus cornigerus (*O. S.*).
Fig. 4. Amphibolips confluentus (*Harr.*).
" *5.* " inanis (*O. S.*).
" *6.* " ilicifoliæ (*Bass.*).

PLATE XI.

Fig. 1. Andricus futilis (*O. S.*).
" *2.* " similis (*Bass.*).
" *3.* " clavula (*Bass.*).
Fig. 4. Andricus singularis (*Bass.*).
" *5.* " lana (*Fitch*).
" *6.* Cynips (?) prinoides *Beut.*

PLATE XII.

Fig. 1. Acraspis erinacei (*Walsh*).
" *2.* Neuroterus floccosus (*Bass.*).
" *3.* Dryophanta polita (*Bass.*).
Fig. 4. Holcaspis globulus (*Fitch*).
" *5.* " duricoria *Bass.*
" *6.* Cynips strobilana *O. S.*

PLATE XIII.

Fig. 1. Neuroterus batatus (*Fitch*).
" *2.* Andricus petiolicola (*Bass.*).
Fig. 3. Biorhiza forticornis (*Walsh*).
" *4.* Cecidomyia serrulatæ *O. S.*

PLATE XIV.

Fig. 1. Cecidomyia holotricha *O. S.*
" *2.* " caryæcola *O. S.*
Fig. 3. Cecidomyia persicoides *O. S.*
" *4.* " tubicola *O. S.*

PLATE XV.

Fig. 1. Cecidomyia strobiloides *O. S.*
" *2.* " rigidæ *O. S.*
" *3.* " pilulæ (*Walsh*).
Fig. 4. Cecidomyia poculum *O. S.*
" *5.* " clavula *Beut.*

PLATE XVI.

Fig. 1. Pachypsylla venusta *O. S.*
" *2.* " cucurbita *Riley.*
" *3.* " gemma *Riley.*
" *4.* Hormaphis spinosus (*Shimer*).
Fig. 5. Hormaphis hamamelidis *Fitch.*
" *6.* Pemphigus rhois *Fitch.*
" *7.* Acarus serotinæ *Beut.*

Article XVI.—NOTES ON BIRDS AND MAMMALS OBSERVED NEAR TRINIDAD, CUBA, WITH REMARKS ON THE ORIGIN OF WEST INDIAN BIRD-LIFE.

By Frank M. Chapman.

INTRODUCTORY.

Trinidad is situated on the southern coast of Cuba, about 400 miles from the eastern, and 350 from the western extremity of the island. The shore at this point is formed of recent coral limestone. Three miles inland this has been upheaved, and appears as a line of hills parallel to the coast, about thirty miles in length and reaching an altitude of 900 feet.

From the summits of this coast-range one looks north across the noble valley of Trinidad. This valley is three miles in width and about thirty in length. Its southern boundary is formed by the low range just mentioned, while its northern side is defined by the foot hills of the San Juan Mountains. It is celebrated for its fertility, and is, or has been, almost entirely devoted to sugar-cane plantations. The San Juan Mountains are largely formed of a palæozoic limestone. They are irregular and picturesque in outline and seamed by narrow valleys, down which dash clear mountain streams on their way to the sea. Their average height is from 2500 to 3000 feet, and one peak, Portrerillo, reaches an altitude of 4000 feet.

The region about Trinidad, then, may be divided into three quite different districts: first, the coast, including the southern slope of the coral limestone hills; second, the Trinidad Valley; third, the San Juan Mountains. During the month and a half (March 1–April 14, 1892) in which I collected in this region I visited localities in each of the districts mentioned, and a description of them will serve also for the districts in which they are included. They may be considered in natural, or what proved to be the reverse, order in which they were visited.

Casilda (April 10–14).—Casilda is the port of Trinidad. The harbor is formed by a crescentic-shaped sand-bar which reaches out from the shore and partly encloses a basin about two miles in diameter. On the sea side there is a hard, fine beach ; on the bay side there are extensive mangrove swamps and large grassy marshes. The place seemed admirably adapted to support an aquatic avifauna, which nevertheless was largely wanting. Brown Pelicans and Cormorants were not uncommon, and Clapper Rails were apparently numerous in the mangroves. Beyond these I did not observe ten individuals of any species of water bird. The distance from the coast to the summit of the coast hills, near which is situated the city of Trinidad, is between three and four miles. The growth here is scattered, low and scrubby, the absence of royal palms being especially noticeable. Birds are comparatively rare.

Guanayara (April 5–9).—Guanayara is at the base of the mountains, eight miles west of Trinidad. There is no beach here, and the sea breaks on a solid wall of conglomerate coral limestone. At a distance of about one mile from the shore this formation meets the palæozoic rocks of the mountains. The line of connection is clearly marked by the royal palms which grow at the extreme edge of the older formation, but, as on the coast-range at Trinidad, this tree was not found in the recent coral limestone. My collecting here was largely limited to the newer land which flanks the mountains. On this tract the growth presents every gradation from the recently established running vines and hardy *Borricha*, growing within ten feet of the sea, to woods resembling second-growth with dense thickets underneath. Birds of certain species were abundant, but there were wanting a number of species found at both San Juan and San Pablo.

San Pablo (March 15–30).—San Pablo is in the Trinidad Valley, fifteen miles east of Trinidad. The valley is largely devoted to raising sugar and tobacco, but there are great tracts of fallow land given up to grazing and resembling northern pastures, and, where the cattle are not numerous, they are covered with a growth of guava bushes. At this point the valley is traversed by the Agabama River, in the winter a shallow stream about fifty feet in width and with treeless banks. San Pablo is on the northern side of the valley, near the foothills of the San Juan chain. These low hills and their intervening valleys are generally well wooded, and in the latter are small streams bordered by a more or less dense tropical growth. Localities of this nature furnished the best collecting ground. Indeed the great diversity of ground at San Pablo gave rise to a richer avifauna than I found at any other place. In the 'old fields' of the valley were Meadowlarks and Yellow-winged Sparrows; on the Agabama were Jaçanas and Gallinules, and in the guavas and wooded hills and valleys were found all the species of woodland birds which I observed in Cuba.

San Juan de Letran (March 1–13).—The valley of San Juan is eight miles north of Trinidad at an altitude of 2000 feet in the San Juan Mountains. It is one of many small valleys, averaging a quarter of a mile in width, enclosed by the mountain tops, which at this point were about four hundred feet above the level of the valley. The summits and sides of the mountains were here covered by a dense growth of high, wiry grass, and numerous but scattered small palmettoes, and a species of agave bearing a yellow flower which was abundant at the time of my visit. As a rule each valley is watered by a clear mountain stream, and when the ground is not under cultivation by the mountaineers, it supports a fairly dense vegetation. Royal palms, averaging about sixty feet in height, are here, as elsewhere, the most abundant and characteristic trees.

San Juan was the realization of a naturalist's dream of the tropics. With the kindly hospitality, which I everywhere encountered, a resident mountaineer placed an unoccupied thatched cabin at my disposal, and having a young native to cook for me, I was thus most favorably situated for collecting. The nature of the country, too, was such as to focus the birds within comparatively narrow limits, and for this reason they were exceedingly abundant. In or near the clearing about my house grew royal and cocoa palms, mangoes, bananas, oranges, lemons, guavas and coffee, and from my door I saw, with few exceptions, all the species of birds I observed in the mountains. Altitude here has apparently no influence on the distribution of birds.

The absence at San Juan of certain species found at San Pablo was evidently due to purely local conditions; as for example, the lack of large fields suitable for Meadowlarks, or of a body of water suitable for the habitation of Jaçanas.

During my stay at or near Trinidad I was everywhere so hospitably received I have difficulty in fitly expressing my thanks. Mr. B. W. Morrill, Sres. Eduardo Caret and Manuel Fernandez, Sarjento Prats of the Guardia Civil, and Captain White of the American Schooner 'City of Philadelphia,' all rendered me invaluable assistance, which I desire to gratefully acknowledge; and I would especially thank Mr. Daniel Quayle, the American Consular Agent at Trinidad, whose home and services were always freely offered me.

I.—Notes on Cuban Birds.

General Impressions of Cuban Bird-life.—One familiar with the bird-life of only the middle Atlantic States of America would, I think, return from a morning in the woods of San Juan or San Pablo with three prominent impressions of Cuban birds; first, their abundance; second, their comparative tameness; third, their lack of song power. Probably the second characteristic contributes to the force of the first. Of some eighty species found at San Pablo it was customary to observe about two-thirds each day, while in the vicinity of New York City it is not usual to observe more than one-third of the summer-resident fauna during a day's outing.

The restrictions imposed by the government on the use of fire-arms, the high price charged for ammunition, and the absence of game, except Quail and Doves, are excellent reasons why there should be little shooting in Cuba, and during my stay I encountered but three gunners, all of whom were hunting Doves (*Zenaidura*, *Zenaida* and *Columba corensis*). Birds, therefore, are molested but little, and as a result many of them display an unusual confidence in their human neighbors. For this reason, and also because of their abundance and continuous presence, they are far better known to the natives of all classes than are our common birds. The inhabitants of the country were particularly well informed, and seldom failed to recognize the permanent resident birds, either by their appearance or notes. Children of not more than eight years of age could generally name at sight most of the birds on my work table. A general knowledge of resident birds, however, was not confined to the inhabitants of the country, and on one occasion, in a restaurant in Trinidad, I was somewhat surprised to hear a discussion on the identity of the Flycatcher, known as Pitirre (*Tyrannus domincenus*), while the debate over the bird's time of arrival from the south became animated.

In saying that Cuban birds displayed a lack of song power I would not imply that they lack in vocal power; on the contrary, many of them are exceedingly noisy, and the woods and clearings resound with strange and sometimes not unmusical call-notes, cries and whistles. At San Juan the clearings, low growth and woods were in close proximity, and, as before stated, birds were more abundant here than elsewhere. The morning chorus was opened by the soft, plaintive cooing of the Zenaida and Zenaidura Doves and the more vigorous notes of the Torcaza. They were followed by the singular call-notes and whistles of the two Blackbirds (*Quiscalus* and *Ptiloxena*). Then the chattering notes of the Guatibero (*Pitangus*), the rolling call of the Carpintero (*Centurus*), the attempt at song of the Zorzal (*Mimocichla*) were added to the chorus; while at intervals one heard the *kr-r-row* of Trogons, the complaining note of the Anis, the mournful whistle of the diminutive Siju Owl, or the grating cries of a passing flock of Paroquets.

In the open valley at San Pablo birds were of course less abundant, and the characteristic species here were the Carolina Doves and Meadowlarks.

At the time of my visit woodland birds were feeding on the fruit of the cupey tree, and were always abundant in the vicinity of trees bearing ripe fruit.

On one occasion, while sitting beneath one of these trees, I heard or saw on or near it, within a period of ten minutes, eighteen species of birds, of which all but two, the Black-throated Blue Warbler and Black-whiskered Vireo, were peculiar to Cuba.

They included three species of Woodpeckers, three of Blackbirds, two Flycatchers (*Pitangus* and *Myiarchus*), Crows, Parrots, Paroquets, Trogons, Negritos, Zorzals and Todies.

Although I observed some twenty species of the North American land-birds which occur in Cuba during the winter only, the part played by these birds in the avifauna was, with five exceptions, an unimportant one.

These five birds mentioned, in the order of their abundance, were Black-throated Blue, Palm and Prairie Warblers, Redstarts, and Catbirds.

The nesting season among the Passeres in Cuba is apparently not fairly under way until after the middle of April. Some species commence to breed in March, but the real breeding season was evidently about to open at the time I left Guanayara. Early in March, however, I observed that birds which do not nest until late in April were in pairs. It seems not improbable that some of these sedentary insular species may be mated for life.

The Migration.—Beyond the arrival of three species, which are found in Cuba during the summer only, I observed no evidences of a migration. There were apparently no flights of transients *en route* to the North, and no marked fluctuation in the numbers of the winter visitants was noticed.

It is probable that by far the larger number of migrants which touch Cuba in going from the United States go to the westward and cross from Cape San Antonio to Yucatan in preference to following the Cuban coast to the eastward and thence continuing their journey through Jamaica, or San Domingo, Porto Rico and the Lesser Antilles. In returning in the spring it is natural to suppose they would retrace the course of the previous fall.

Birds Observed while Sailing from Batabanó to Trinidad.—Few birds were observed while sailing along the southern coast of Cuba. From Cienfuegos to the bar which makes the harbor of Trinidad, the shore is an almost continuous wall of coral limestone; there are no shoals or sandy beaches and no birds were seen. Between Cienfuegos and Batabanó the water is shallow, and there are innumerable mangrove islands varying in size from the small sand-bar, on which a few mangrove shoots had but recently taken root, to the older islands having an area of thirty or forty acres. One would expect to find water-birds here in abundance, but seven Laughing Gulls, several hundred Cormorants, about fifty Frigate Birds, a few Brown Pelicans, and two great White Herons (*Ardea occidentalis*), were the only ones observed.

The Cuban Avifauna.—It is largely to that fine old naturalist, Dr. Juan Gundlach, that we owe our knowledge of Cuban birds. For fifty-four years he has pursued his studies of the Cuban fauna, and from his report on the birds[1] I make the following analysis:

Total number of species recorded	257
Land-birds	156
Water-birds	101
Permanent residents	130
Transient visitants	39
Winter residents	81
Summer residents	7

The number of species peculiar to the island, and a comparison of the extent of the avifauna with that of other West Indian Islands, will be found in a succeeding part of this paper.

In two genera, *Teretistris* and *Mimocichla* (see remarks under the latter) species ranging throughout Cuba seem to have became differentiated into two well-marked forms, an eastern and a western. Careful comparison of large series of birds will doubtless show that other wide ranging Cuban species are perhaps separable into eastern and western races.

Species Described as New or Added to the Cuban Fauna.—In the present paper the following species and subspecies are described as new or described under new names: *Rallus longirostris cubanus*, *Columbigallina passerina terrestris*, *Pitangus jamaicensis*, *Dendroica petechia flaviceps*, *Capromys columbianus*. "*Dives*" *atroviolaceus* is placed in a new genus *Ptiloxena*. *Colinus virginianus floridanus* is added to the Cuban fauna, and the Red-tailed Hawk is given as *Buteo borealis calurus*.

[1] Journ. für Orn., XIX, 1871, pp. 265–295, 353–378; XX, 1872, pp. 401–432; XXII, 1874, pp. 113–166, 286–308; XXIII, 1875, pp. 293–340, 353–407.

Annotated List of Birds Observed.

In the following notes on birds observed near Trinidad the expressions abundant, common, etc., without mention of locality, refer to Guanayara, San Pablo and San Juan when applied to land-birds, and to Casilda when applied to water-birds.

When no doubt of identity existed I have given the local native name. In other cases I have given in quotation marks the native name from Gundlach's 'Beiträge zur Ornithologie Cubas' (l. c.). When practicable this is followed by the English equivalent.

1. **Colymbus dominicus** *Linn.* Zaramagullon Chico. St. Domingo Grebe.—Two pairs of this little Grebe were found in the Trinidad River near its headwaters in the San Juan valley. The river at this point is a mere mountain stream, which in places widens into small pools. A female taken March 4 was molting and had lost all the quills of both wings.

2. **Podilymbus podiceps** (*Linn.*). Zaramagullon Grande. Pied-billed Grebe.—Several observed at San Pablo.

3. **Sterna maxima** *Bodd.* "Gaviota." Royal Tern.—Not common.

4. **Anhinga anhinga** (*Linn.*). "Marbella." Anhinga.—But two observed.

5. **Phalacrocorax dilophus floridanus** (*Aud.*). "Corua." Florida Cormorant.—Common.

6. **Pelecanus fuscus** *Linn.* "Alcatraz." Brown Pelican.—Common.

7. **Fregata aquila** (*Linn.*). "Rabihorcado." Man-o'-War Bird.—Not uncommon. During a severe storm on March 7 three of these birds were seen at San Juan. The wind was blowing the sea mist rapidly across the tops of the mountains, but high above these lower clouds the Man-o'-War Birds floated calmly, apparently undisturbed by the elements.

8. **Anas discors** *Linn.* Blue-winged Teal.—One seen at San Pablo.

9. **Aix sponsa** (*Linn.*). PATO DE LA FLORIDA.[1] WOOD DUCK.—Two pairs of these birds frequented a forest brook at San Pablo. A pair taken March 19 had the sexual organs but slightly enlarged. They were said by the natives not to remain during the summer.

10. **Ardetta exilis** (*Gmel.*). "GARZITA." LEAST BITTERN.—One specimen taken in the mangroves at Casilda.

11. **Ardea occidentalis** *Aud.* "GARCILOTE BLANCO." GREAT WHITE HERON.—One observed at Casilda.

12. **Ardea wardi** *Ridgw.* WARD'S HERON.—Observed on several occasions, but no specimens were secured. It is more than probable, however, that the Cuban bird should stand as *wardi* rather than *herodias*.

13. **Ardea egretta** *Gmel.* GARZA BLANCA. AMERICAN EGRET.—There was a flock of about twenty of these birds at San Pablo which came each night to roost in a tree at the border of the river. They appeared in a body with much regularity just after sunset, and after circling about the tree once or twice alighted on its branches. One now heard a low croaking chorus as the birds selected perches and settled themselves for the night. This rookery was but 200 yards from the houses and mill of the estate, and not more than sixty feet from a well-travelled road. The confidence thus displayed by the birds in their choice of a roost was in striking contrast with the habits of the shy, much-hunted Egret of Florida. During the day single birds were sometimes observed in cane-fields from which the cane had been cut. They were doubtless feeding on the lizards which abounded in ground of this nature.

14. **Ardea cœrulea** *Linn.* GARZA AZUL. LITTLE BLUE HERON.—Not uncommon.

15. **Ardea tricolor ruficollis** (*Gosse*). LOUISIANA HERON.—About twenty were observed at Casilda.

16. **Ardea virescens** *Linn.* "AGUAITA CAIMAN." GREEN HERON.—Common along mountain streams.

[1] Dr. Gundlach applies this name to the preceding species, calling the Wood Duck "Huyuyo."

17. Nycticorax nycticorax nævius (*Bodd.*). "GUANABÁ DE LA FLORIDA." BLACK-CROWNED NIGHT HERON.—Two observed at Casilda.

18. Aramus giganteus (*Bonap.*). GUARACAO. LIMPKIN.—A common bird at San Pablo, where they frequented the guava-grown uplands, probably to feed on land-shells. They were exceedingly wary. They were rarely, if ever, heard calling during the day, but soon after nightfall and throughout the night one could hear the weird cry from which they receive their native name.

19. Rallus longirostris cubanus, subsp. nov.

"GALLINUELA." CUBAN CLAPPER RAIL.

Char. Subsp.—Intermediate in coloration between *Rallus longirostris caribæus* Ridg. and *Rallus longirostris scotti* Senn. Of a darker and less reddish shade of brown, and with less white on the abdomen than *caribæus;* not so dark as *scotti.*

Description of Type (No. 57,391, Coll. Am. Mus. Nat. Hist., adult male, Casilda, coast of southern Cuba, April 14, 1892. Collected by Frank M. Chapman, Collector's No. 2707).—Upper parts dark sepia brown, the feathers of the back bordered laterally with olivaceous gray; wings and tail of a lighter brown than the back; tertials slightly darker than the back and with the lateral margins grayer; a buff superciliary stripe; lores and subocular region blackish; post-ocular region gray; chin and throat white bordered by deep buff, which on the neck has a grayish tinge and on the entire breast becomes cinnamon; flanks and under tail-coverts of nearly the same color as the wings, the feathers with narrow transverse white bands bordered by blackish areas; middle of the abdomen whitish, the feathers with indistinct, tranverse dusky bands. Wing, 5.98 in.; tarsus, 2.14; culmen, 2.44; depth of bill at posterior margin of nostril, .41 in.

Description of Female (No. 57,389, Coll. Am. Mus. Nat. Hist. Same date, locality, and collector. Collector's No. 2702).—Similar to the male but smaller, the sides of the throat, neck and breast paler. Wing, 5.20; tarsus, 1.90; culmen, 2.18; depth of bill at posterior margin of nostril, .38 in.

Six specimens of this new Rail were collected at Casilda. Two of these are fully-grown young of the year, which differ from the adults only in having the throat and chin buffy instead of white.

For comparison with these birds I have had, through the courtesy of Messrs. Brewster, Ridgway and Sennett, specimens of *carribæus*, *scotti*, and also one example of *saturatus*. This included the type of *caribæus*, while in the American Museum Collection there are the types of *scotti* and one example of true *longirostris* from Bahia. Comparison of *cubanus* with this material shows that while it is more closely related to *scotti* than to any known form it evidently connects *scotti* with *caribæus*. Thus the darkest Cuban example is inseparable from a pale specimen of *scotti*, and on the other hand the palest Cuban birds are scarcely distinguishable from the darkest specimens of *caribæus*. From *saturatus*, *cubanus* is apparently separated by its browner color and gray instead of brown margins to the feathers.

I have provisionally adopted Mr. Sennett's nomenclature for *crepitans* and *saturatus*,[1] but, as previously stated by Mr. Brewster and myself,[2] I believe that a larger number of specimens than we at present possess will show a complete intergradation between all the forms of this group, with the probable exception of the Bahaman *Rallus coryi*.

The Cuban Clapper Rails were common in the mangroves at Casilda. The breeding season was evidently over before April 14, for on that date I secured the two fully-grown young birds before mentioned.

20. **Gallinula galeata** (*Licht.*). GALLINETA. FLORIDA GALLINULE.—Common in pairs at San Juan.

21. **Tringa minutilla** *Vieill.* "ZARAPICO." LEAST SANDPIPER.—One observed at Casilda.

22. **Symphemia semipalmata** (*Gmel.*). "ZARAPICO REAL." WILLET.—A flock of eight was observed at Casilda. None were secured, and it is possible they may have belonged to the western race *inornata*.

23. **Actitis macularia** (*Linn.*). "ZARAPICO." SPOTTED SANDPIPER.—Not uncommon at San Pablo.

24. **Charadrius squatarola** (*Linn.*). BLACK-BELLIED PLOVER.—One observed at Casilda.

[1] Auk, 1888, p. 161. [2] *Ibid.*, 1889, p. 136.

25. **Ægialitis vocifera** (*Linn.*). "FRAILECILLO." KILDEER.—Not common.

26. **Ægialitis wilsonia** (*Ord*). "FRAILECILLO." WILSON'S PLOVER.—A pair of breeding birds was taken at Guanayara. The male is in fully adult plumage, but lacks the cervical collar, which in most high-plumaged specimens of this species is nearly complete.

27. **Jacana spinosa** (*Linn.*). GALLITO. MEXICAN JACANA.—Found only at San Pablo, where they were not uncommon along the Agabama River. Here they feed among small lily-pads not more than two inches in diameter, growing in water several feet deep. If they paused the leaves sank beneath them, when they would take to the water, swimming easily and somewhat like a Coot (*Fulica*).

28. **Colinus virginianus cubanensis** (*Gld.*). CODORNIZ. CUBAN BOB-WHITE.—Two males and a female of this bird were taken from a small flock in the mountains.

29. **Colinus virginianus floridanus** (*Coues*). CODORNIZ. FLORIDA BOB-WHITE.—Six Quails were secured at San Pablo, where they were apparently not uncommon. They frequented the guavas, cane-fields and tobacco plantations. The familiar *bob-white* and 'scatter calls' were first heard on March 23, when the birds were still in flocks and evidently just beginning to mate.

Of four males one is typical of the very dark Quail from southern Florida, while the other three are intermediate between this form and true *cubanensis*. The two females apparently agree with the Florida bird, and are easily distinguishable from the females of true *cubanensis*.

I can account for the presence of these birds only on the supposition that Florida Quails have at some time been introduced in Cuba, and that they have interbred with the native birds. The explanation is not unreasonable, for we know that Quail have been introduced into other West Indian Islands.[1]

[1] *Cf.* Gundlach, J. f. O., 1874, p. 300. Dr. Gundlach, however, confused the two birds, for I have seen specimens of true *cubanensis*, and one equally typical of the Florida bird, which had been collected by him in Cuba and labeled *cubanensis*.

30. **Columba corensis** *Gmel.* Torcaza.—Common, frequenting the royal palm trees, the berries of which seemed to constitute its sole food. One individual had no less than eighty of these berries, each measuring three-eighths by one-half of an inch in diameter, in its crop. The Torcaza is thus an active agent in distributing the seeds of palm trees. The call of the Torcaza is a vigorous *too-whòo*, *coo*, *too-whòo*, *coo*, with the accent strongly pronounced.

31. **Columba leucocephala** *Linn.* Torcaza Cabeza Blanca. White-crowned Pigeon.—Single birds were observed on two occasions.

32. **Zenaidura macroura** (*Linn.*). Paloma. Mourning Dove.—Everywhere a common species. At San Pablo they were exceedingly abundant, and there were few intervals during the day when their call could not be heard. In the afternoon in walking over the weed-grown bottom of a former course of the Agabama River, at nearly every step this species and the Ground Dove arose in small flocks from almost beneath my feet. They evidently came here to procure the fine gravel which had been brought by the river.

At the time of my visit the birds were breeding, placing their nests in the guava bushes, or even in the palm trees, where the leaves branch out from the trunk. I now frequently observed a peculiar aërial evolution which probably is confined to the breeding season. I have previously observed it only at Corpus Christi, Texas, where also the birds were breeding. This evolution consists of a short, unnatural flight, followed by a sail, which is sometimes over a circular course. This may be repeated two or three times, and the bird then sails to the ground or a near-by perch. The whole performance does not cover over two hundred feet, and is presumably confined to the vicinity of the nest. At least on several occasions I observed it directly above a nest. During this flight and sail the bird so exactly resembles an *Accipiter* that I never saw one engaged in it without involuntarily grasping my gun to shoot what I had mistaken for a Hawk. Indeed, so close is the resemblance, it is only after careful scrutiny that one recognizes the Dove.

Cuban specimens are smaller than examples of *Z. macroura* from the eastern United States, and in their slightly darker color and disproportionately shorter tail, they show an approach to *Zenaida zenaida.* Average measurements are as follows: five Cuban specimens, wing, 5.52; tail, 4.81 in. Five specimens from the vicinity of New York City, wing, 5.92; tail, 5.40 in.

33. **Zenaida zenaida** (*Bonap.*). GUANARO. ZENAIDA DOVE. —Common. It is more of a ground Dove than *Zenaidura*, and is therefore less frequently seen. Its notes resemble those of *Zenaidura*, but are deeper, louder and more solemn.

34. **Columbigallina passerina,** subsp. TOJOSITA. GROUND DOVE.—Common.

Throughout its range this small Dove presents much variation in the color of the bill, and to a less extent in the color of the plumage. It is not always possible to determine from dried specimens what was the color of the bill in life, and as few specimens are labeled with regard to this point much of the existing material is misleading. So far as I am aware, in eastern North America and the West Indies, the bill assumes three styles of coloration, as follows: In eastern North America it has the basal half or two-thirds coral red, the tip black or blackish. (In dried specimens the red becomes orange or yellow, and is then indistinguishable from the next.) In Jamaica (*cf.* Scott, Auk, IX, 1892, p. 124) it has the basal half or two-thirds yellow. Mr. Scott informs me that his remarks, as above referred to, are based on fresh specimens. In the Bahamas, according to Mr. Maynard, the bill is "constantly and wholly black." This is one of the characters on which he establishes his *Chamæpelia bahamensis* (*cf.* Am. Ex. and Mart., III, 1887, p. 33).

Cuban birds have the bill in life brownish black, darker at the tip, and with a faint reddish cast basally. The general appearance is that of a black bill, but as I have been unable to make an extended comparison of the Cuban and the Bahaman birds I cannot affirm their identity.

The bird from eastern North America, as before remarked, differs from true *passerina* of Jamaica in having the base of the bill red instead of yellow; there are also differences in coloration.

Mr. Scott has permitted me to examine his fine series of some forty Jamaican specimens, and comparison of these with some twenty examples from Florida shows that they may be separated into two well-marked races. Jamaican males are slightly paler and have whiter throats than Florida males. In the females the difference is more marked, Jamaican birds having the throat whiter, the breast more finely squamate, and the abdomen whiter, and they lack the pinkish tinge seen in Florida specimens. In size the sexes are alike, and, as might be expected, Jamaican birds are somewhat smaller. Five males and five females from Jamaica measure: wing, 3.25; tail, 2.06; bill, .44 in. An equal number of both sexes from Florida measure: wing, 3.50; tail, 2.30; bill, .44 in. It is evident then that the name *passerina* can no longer be accepted for the bird from eastern North America. In describing his *bahamensis* Mr. Maynard remarks (l. c.): "'Tis only after considerable hesitation that I name these species even provisionally; 'tis also possible that Limnaeus [*sic*] of *Columba passerina* was based on specimens of this species and not on birds of the continent of North America. In event of this proving the case, I propose the name of *Chamæpelia purpurea* for the larger continental Dove." It seems to me, however, that this name is unavailable from either logical or zoölogical grounds. The "event" which Mr. Maynard specifies has not 'proved to be the case,' nor does he designate which of the North American races of *Columbigallina* he proposes to call *purpurea*. Very probably he intended to name the race from eastern North America, but his remarks are so vaguely worded as to be capable of several interpretations. Furthermore, Mr. Maynard did not know the true *passerina*, and he thus fails to mention the differences which serve to distinguish the eastern North American bird from the bird which Linnæus named. In view of the unsatisfactory basis on which the name *purpurea* stands it seems unwise to recognize it, and I suggest, therefore, that the Ground Dove of eastern North America be known as *Columbigallina passerina terrestris*.

35. **Geotrygon montana** (*Linn.*). BOYERO. RUDDY QUAIL-DOVE.—A few were observed and several collected beneath the cupey trees at San Pablo. They were feeding on the fallen fruit

of this tree. Their flight is noiseless, and on being flushed they fly for but a short distance and then alight on the ground or in the low undergrowth. Their flesh is more delicate than that of any bird I have ever eaten.

Starnœnas cyanocephalus was reported to me, under the name Perdiz, as being a rare inhabitant of the mountains. I did not meet with it.

36. **Cathartes aura** (*Linn.*). AURA. TURKEY VULTURE.—Abundant.

37. **Circus hudsonius** (*Linn.*). GAVILAN. MARSH HAWK.—Four were observed near San Pablo.

On six occasions I observed individuals of an *Accipiter*, but secured no specimens.

38. **Buteo borealis calurus** (*Cass.*). GAVILAN. WESTERN RED-TAIL.—Red-tailed Hawks were not uncommon, but I secured only one specimen (No. 57,400), an adult male. Comparison with a large series of both *borealis* and *calurus* shows that the relationships of this specimen are with the latter rather than the former. The chin and upper throat are white, but the sides of the neck, breast, and abdomen are heavily marked with deep rufous or black, as in some specimens of *calurus*. The tail has a broad black subterminal band, and all the rectrices have traces, more or less distinct, of black bars. This Hawk, according to Gundlach, is resident in Cuba, and it is not improbable that further material will show it to be an insular race. The specimen just described measures: wing, 15.00; tail, 9.50; tarsus, 3.00 in.

39. **Falco sparverioides** *Vig.* CERNICALO. CUBAN SPARROW HAWK.—Common. With few exceptions all the Sparrow Hawks I saw were mated and preparing to breed, and at Guanayara one pair was nesting in a hole in a palm tree. Of fourteen specimens secured nine are of the light and five of the dark phase of plumage. Most of these specimens were taken in pairs, and in every case dark birds had dark mates and white birds white ones. In addition to these specimens a number of pairs were satisfactorily identified, but on no occasion were the two phases seen

together. The calls of both phases are alike, and resemble that of *Falco sparverius.*

In his forthcoming 'Catalogue of West Indian Birds,' advance sheets of which I have just (November 25) been permitted to see, Mr. Cory gives reasons for considering the San Domingo bird separable from the Cuban bird, basing his conclusion on the comparison of forty-six specimens from the former island and twenty-five from the latter. The name *dominicensis*, provided this determination proves correct, should therefore be restricted to the San Domingo bird, which apparently has but one, the light, color phase.

The Cuban bird should therefore stand as *sparverioides*, and the real point at issue is the identity or distinctness of the two very different color phases which the Sparrow Hawk assumes in Cuba.

It has been shown that the two phases intergrade; it is equally certain, I believe, that they breed together, and Mr. Cory states (l. c., p. 140) that he is informed that "birds of both colors have been taken from the same nest." The question is then whether this is an instance of dichromatism or hybridism. If the former it is certainly one of the most exceptional cases of which we have any knowledge. *Falco sparverius* and its several closely-allied forms range throughout the greater part of North and South America, and are found in nearly every island of the West Indies. At no point in this extended habitat does it give any indication of developing two color phases except in the island of Cuba. The differences which distinguish the two color phases are not such as occur in pure dichromatism, but involve also a change in the pattern of coloration. In the light phase the adult male has the underparts, including the lining of the wing, nearly pure white, while the back is cinnamon, as in *sparverius.* In the full development of the dark phase the underparts, except the throat, are deep cinnamon; *the lining of the wings is heavily barred with blackish;* the back is blue and of the same color as the head, but with traces of cinnamon on some of the feathers. In addition to these changes there is a deepening in the coloration of the other parts. Great as are the differences which exist between these phases they are not greater than those which we know occur among Hawks; but the case becomes more remarkable when we consider that so radical a variation in coloration occurs in only one small part of the habitat of the species.

40. **Polyborus cheriway** (*Jacq.*). CARAIRA. AUDUBON'S CARACARA.—Three individuals were observed and one secured at San Pablo.

41. **Pandion haliaëtus carolinensis** (*Gmel.*). "GUINCHO." AMERICAN OSPREY.—One observed at Casilda.

42. **Strix pratincola furcata** (*Temm.*). LECHUZA. CUBAN BARN OWL.—Common. Their wild, startling cry was frequently heard at night, and would be followed by a high, rapidly repeated *cr-r-ree*, *cr-r-ree*, *cr-r-ree*, as they flew about in search of food. They live in the caves, evidently choosing such as are inhabited by bats, on which they feed. They also eat mice (*Mus musculus*) and rats (*Mus tectorum*). In the stomach of a specimen shot at noon in a bat-cave were the partially digested remains of three mice and two bats of a species (*Phyllonycteris poeyi*) which measured twelve inches in expanse of wing.

43. **Glaucidium siju** (*D'Orb.*). SIJU. CUBAN PIGMY OWL.—A common and apparently entirely diurnal species. Their usual note, a softly whistled *coo*, is one of the characteristic sounds of Cuban woods, and may be heard at all hours of the day. Their favorite perch when calling is near the top of a tall leafless tree, and I have seen them in this exposed position facing the sun. The short *coo* is uttered at intervals of about five seconds, and may be continued for more than an hour at a time. It is accompanied by a nervous, vertical twitching of the tail, which is sometimes raised to form an acute angle with the back. A second vocal performance, but a less common one, seemed to be the result of excitement and may be confined to the nesting season. It consists of a series of short whistles, rising in tone, uttered with increasing rapidity, and ending in a high piercing note. Their food seemed to consist of insects, small tree-toads and lizards.

On one occasion I heard a male of this species calling in a grove of cocoa-nuts. He was found without difficulty, and on approaching I discovered also the female. The male was uttering the *coo*-note and occasionally varying it with the performance just described. To this the female responded with a thin, shrill squeak. As the male was secured the female flew into the top of a dead palm trunk about twenty-five feet in height. A rap at the base of the tree caused her to fly out and she also was secured. She contained an egg ready for deposition. The palm tree was badly decayed and was pushed to the ground. A depression in its top, of about six inches in depth, was evidently the Owl's nest. It was composed simply of the dead palm fibres. In these loose fibres, immediately below and for a distance of about eight feet down, I found twenty-five tree-toads of two species and a 'chameleon.' Some of the toads had bodies three inches long, while the lizard was twelve inches long. As it was more than probable that both had entered this retreat from above, it is natural to suppose they would leave in the same way. But their passage would so evidently interfere with the domestic arrangements of *Glaucidium*, I came to the conclusion that they were in winter quarters and that quite unsuspectingly the Owl had selected a nesting place above them.

A series of fifteen specimens shows that, irrespective of sex, there are two quite different color-phases, a gray and a red, between which there is a complete intergradation. In the red phase the spots or marks on the upperparts are reduced to the minimum, while in the gray phase they are longer and more clearly marked. Sexual variation is shown by the larger size of the females, as follows: six females average, wing, 3.81; tail, 2.43 in.; nine males average, wing, 3.61; tail, 2.30 in.

44. **Amazona leucocephala** (*Linn.*). Cotica. Cuban Parrot.—Found only at San Pablo, where they were not uncommon in small flocks of not more than six individuals. They were frequently found feeding on the fruit of the guava, and were also attracted to the mango trees, the fruit of which was just ripening, and which, during its season, constitutes their favorite food. They are restless birds, spending little time in one place. They fly with a strong, rapid wing-beat, which suggests the flight of a cormorant.

45. **Conurus euops** (*Wagl.*). PERIQUITO. CUBAN PAROQUET.—Common, both at San Juan and San Pablo. They were generally seen in flocks of from ten to twenty, and, like the preceding species, they were restless and much on the wing. Their favorite food seemed to be the berries of the royal palm. They call in chorus while flying and the note is a grating squeak, quite different from the Woodpecker-like *kr-r-r* of *Conurus carolinensis*. Both these species and the Cotica defer their breeding season until late April and early May, when an abundance of ripe fruit assures them of a food-supply for the young.

In a series of sixteen specimens, thirteen have the plumage more or less mottled with red. There is some regularity, however, in the distribution of this color. On the upperparts it is confined to the head and nape. All but one of these specimens have red feathers also on the sides of the head and neck, and all but two have a few red feathers scattered through the plumage of the underparts.

46. **Saurothera merlini** (*D'Orb.*). ARRIERO. CUBAN CUCKOO.—A very common species, living in low growths of bushes more or less dense. Its notes are among the most striking of those of Cuban birds. There is apparently no limit to its vocal ability in certain directions, but its ordinary call commences like the rolling squawk uttered by an old, contented hen on a warm day, and increases in volume and rapidity until the notes are joined. This may be heard at a distance of half a mile. A second call is a *cluck*, followed by a gasping note, which would lead one to suppose the bird was being choked to death. This seems to be the result of revery, and when producing it the bird sits in a pensive attitude with the head drawn down between the shoulders, raising it, however, to call. Its other notes or squawks are varied, and on different occasions, after shooting one bird, a survivor has closely approached and scolded me with more weird and horrible sounds than one can well imagine issuing from the throat of a bird. Their food was found to consist of beetles and lizards. In the stomach of one specimen I found the partially-digested remains of an *Anolis* measuring one and a half inches across the angle of the jaws. The stomach was distended to the utmost and measured seven by five inches in circumference.

While it was not unusual to see this bird on the ground, it is by no means a Road-runner; still, in its habit of mounting a bush or tree by jumping from branch to branch, and then reaching the ground by sailing, it reminded me strongly of *Geococcyx*. It is not shy, and will permit one to approach to within a few yards before hopping or moving by short flights through the bushes, or mounting a tree in the manner described.

47. **Crotophaga ani** (*Linn.*). Judio. Ani.—Common in flocks of from five to twenty individuals. They pass much of their time on the ground and are generally found near herds of cows or hogs. On being alarmed they fly into the nearest bushes or low trees, uttering at the same time a kind of long-drawn complaining whistle, suggestive of the note of the Wood Duck. Perched there, with plumage hanging loose and bedraggled, calling their whining cry, they appear as dispirited and cringing as a whipped cur. Their infrequent long flights are accomplished by alternate flapping and sailing. They roost in the low bushes and crowd so closely together that a roosting flock resembles a bunch of black feathers.

48. **Priotelus temnurus** (*Temm.*). Tocororo. Cuban Trogon.—This beautiful Trogon haunts the more secluded parts of the woods, where it is common and generally found in pairs. It is, as a rule, exceedingly tame and will permit one to approach to within a few feet. Its flight is short, generally from tree to tree, and it passes much of its time resting quietly. The call of the male is a rather melancholy *kr-r-row*, *kr-r-row*, *kr-r-row*, and this note is sometimes muttered while on the wing. To this the female responds with a much lower but somewhat similar note. Perched on the branches of the same tree, or even when out of sight of each other, a pair will thus call for long periods, one answering the other with the greatest regularity.

Their food consists of insects and berries. I have seen them dart at flowers, probably to get the insects in or near the blossom. Berries were taken in the same way, that is, by darting and picking them from the stem on which they were growing. At the moment the fruit was secured the position of the bird was nearly upright, the wings of course were moving, the tail was spread to the utmost, and with its brilliant plumage thus displayed *Priotelus* made a striking picture of tropical bird-life.

49. **Ceryle alcyon** (*Linn.*). "MARTIN PESCADOR." BELTED KINGFISHER.—Not uncommon.

50. **Todus multicolor** *Gould.* PODORERA. CUBAN TODY.—Among the most interesting of West Indian birds are the members of the family Todidæ, the only family of birds peculiar to these islands. Although so unlike them in color and general appearance, they still bear a laughable resemblance to their distant but nearest relatives the Kingfishers. Indeed, a Tody might be described as a green-backed, red-throated Kingfisher less than four inches in length, with a bill and habits resembling those of a Flycatcher.

Although a common species, the Podorera does not take a prominent place in the Cuban avifauna. Its haunts, habits and green color tend to make it an inconspicuous bird. As a rule I found them in pairs, frequenting low bushes in the woods or sometimes among the guavas. Their notes very closely resemble the sharp chittering of the Ruby-throated Hummingbird. When at rest their position is rather upright, the axis of the body being at an angle of about fifty degrees. At this time they frequently raise their head with a curious bobbing movement. All their food is apparently captured on the wing, after the manner of Flycatchers, but they differ from Flycatchers in that they generally seek a new perch after darting for their prey, and also that this perch is more likely to be in the centre of a bush than in the more exposed position a true Flycatcher would select. When they alight with their back to the observer its color harmonizes so well with that of the surrounding foliage that it is difficult to distinguish them. I did not observe, however, that the bird seemed aware of this protective resemblance. Perhaps the most peculiar characteristic of this little bird is the singular wooden whirring sound which sometimes accompanies its flight. After close observation I am convinced that this sound is produced by the attenuate primary found in the wing of both sexes. My reasons for this belief are: (1) that I heard the sound only when the bird flew with more than usual swiftness; (2) the sound corresponded with the short undulations in the bird's flight from bush to bush. Furthermore, neither Gosse (Bds. Jamaica, p. 72), Scott (Auk, IX, 1892, p. 274), nor Taylor (*ibid.*, p. 373) mention this whirring sound in their accounts of the Jamaican species, and on examination I find that in that species the outer quill is shorter and not so attenuate, curved, or stiffened as in the Cuban bird.

51. **Sphyrapicus varius** (*Linn.*). YELLOW-BELLIED SAPSUCKER.—Observed on two occasions.

52. **Xiphidiopicus percussus** (*Temm.*). CARPINTERO REAL. GREEN WOODPECKER.—Common. Though not a 'Sapsucker,' this bird reminds me, in its habits and notes, of the preceding species.

53. **Centurus superciliaris** (*Temm.*). CARPINTERO JABADO.—A very common and noisy species. Its notes resemble those of the Red-bellied Woodpecker, but are louder, and I did not hear the Cuban bird utter the hoarse *chŭh*, *chŭh*, of *Centurus carolinus*.

54. **Colaptes chrysocaulosus** *Gundl.* CARPINTERO RIBERO. CUBAN GOLDEN-WINGED WOODPECKER.—Not uncommon. Resembles *Colaptes auratus* in its habits and notes.

55. **Antrostomus carolinensis** (*Gmel.*). GUABAIRO. CHUCK-WILL'S-WIDOW.—One was collected at San Pablo.

56. **Chordeiles,** sp ?—Nighthawks were first observed on April 13, when they commenced to arrive from the South. I did not secure specimens, and cannot therefore say to which race they belong, though it is probable they were *Chordeiles virginianus minor*.

57. **Cypseloides niger** (*Gmel.*). GOLONDRINA. BLACK SWIFT.—Probably a common species. Flocks of large Swifts were seen almost every evening at San Juan, but at such an enormous height that on only one occasion did I observe an individual near enough to identify it with certainty.

58. **Hemiprocne zonaris** (*Shaw*). GOLONDRINA. COLLARED SWIFT.—A bird of this species flew low over my head near San Pablo. At no other time did I recognize it, though, as before stated, at San Juan large Swifts were frequently seen in the evening at an immense height.

59. **Tachornis phœnicobia** *Gosse*. GOLONDRINA.—This little Swift was common only at San Pablo, and was not seen at either Guanayara or in the mountains. They appeared late each afternoon, coursing rapidly for food, and in their manner of flight somewhat resembled a Bank Swallow.

60. **Sporadinus ricordi** (*Gerv.*). ZUMBADOR. RICORD'S HUMMINGBIRD.—Common. A nest containing two eggs, found March 11, was placed on the swaying branch of a coffee bush. It was composed of green moss, bound about with strips of bark, which hung in flowing streamers five inches below.

61. **Tyrannus magnirostris** *D'Orb.* "PITIRRE REAL." LARGE-BILLED KINGBIRD.—Four individuals, the only ones observed, were secured at San Pablo.

62. **Tyrannus dominicensis** (*Gmel.*). PITIRRE. GRAY KINGBIRD.—This is one of the few birds which are found in Cuba during the summer only. They were first seen on March 19, soon became common, and in April were abundant. At this time they commenced to mate and their noisy chattering cry of *pitirri, pitirri*, from which they receive their local name, was one of the commonest bird-notes.

63. **Pitangus caudifasciatus** (*D'Orb.*). GUATIBERO.—This Flycatcher very closely resembles the Kingbird (*Tyrannus tyrannus*) both in appearance and habits. Its notes, however, are quite different. When excited or in pursuit of another bird it has a cry like that of a nest full of hungry young birds, and when resting it gives utterance to a long rolling *chitter*. In April they commenced to mate and were then particularly noisy, calling long after nightfall. The Jamaican *Pitangus* has been referred by previous writers to the Cuban *P. caudifasciatus;* it is, however, apparently separable, and may stand as

Pitangus jamaicensis, sp. nov.

Char. Sp.—Differing from the Porto Rican *Pitangus taylori*, and the Haytian *P. gabbii*, in being slightly lighter and in having a broad basal and a narrow terminal whitish tail-band; differing from the Cuban *P. caudifasciatus* in being darker and in having the crest bright lemon yellow instead of orange.

Description of type. (No. 42,647, Coll. Am. Mus. Nat. Hist., adult male, Moneague, Jamaica, February, 1865. Collected by Henry Bryant. Collector's No. 2227.)—Head dark brownish black with a partly concealed crest of bright lemon yellow and not sharply defined from the hair-brown back; wings of the same color as the back, the outer margins of the coverts and tertials whitish, the axillaries and lining of the wing pale yellow; tail of same color as the head, the inner margins of the feathers whitish for their basal third; outer vanes of the lateral feathers whitish and a narrow terminal whitish band; underparts white. The female is similar to the male.

Comparison of five Jamaican specimens with nineteen specimens from Cuba show the characters assigned the new form to be constant so far as this material goes.[1]

64. **Myiarchus sagræ** (*Gundl.*). Bobito.—Not uncommon. It resembles a *Contopus* in habits, and its call has the same plaintive quality as has the note of *Contopus virens*.

65. **Blacicus caribæus** (*D'Orb.*). Bobito.—Very common. It resembles the Wood Pewee in habits but lives nearer the ground. Its notes also are suggestive of those of *Contopus virens*. A nearly completed nest, found April 9, was placed in a fork of an outer branch of a guasima tree about fifteen feet from the ground. It was constructed of grasses, small twigs and plant-down.

66. **Corvus nasicus** *Temm.* Cao.—Found only at San Pablo, where they were not uncommon in the woods and were feeding on the fruit of the cupey tree. Their call is a high, penny trumpet-like note, delivered after the manner of a Crow's *caw*, but frequently accompanied by a series of prolonged squawks, the whole performance sounding quite uncrow-like.

67. **Agelaius humeralis** (*Vig.*). Mayito.—Abundant. It was found feeding among the blossoms of trees, and in its

[1] Since writing the above I have, through the kindness of Mr. W. E. D. Scott, been permitted to examine his fine series of sixty odd specimens of the Jamaican *Pitangus* and they confirm the validity of the species.

habits resembles an *Icterus* rather than an *Agelaius.* It has, however, a Blackbird-like *cack* and a single whistle not unlike that of *Agelaius phœniceus.* I have also seen it, with drooping wings and spread tail, utter the hissing note of *Molothrus ater.*

68. **Sturnella hippocrepis** *Wagl.* Sabanero. Cuban Meadowlark.—Found only in the Trinidad Valley, where they were abundant in old fields. No bird I observed in Cuba proved more interesting than this Meadowlark. I first met with it on March 15, when during a ride through the Trinidad Valley I had an excellent opportunity to become familiar with its song and habits. My impression of the bird's song as given in my journal for that day is as follows:

"The vocal organs of *Sturnella* are apparently so modified by climatic influences that although some naturalists have pronounced its various races to be one species, no one, I am sure, would recognize in the song of the Cuban bird any resemblance to that of *Sturnella magna.*"

Subsequent familiarity with this peculiar song led me to slightly alter this first opinion. It was subject to great variation, and occasionally I could distinguish some faint resemblance to the song of *S. magna.* I was more frequently reminded, however, of the song of the Dickcissel (*Spiza americana*). After several unsuccessful attempts to express in words the typical song of *Sturnella hippocrepis,* I found the syllables, *whēē-chēwēē, chŭckle-chŭr,* to be a not unsatisfactory description of it. The first two syllables have a whistled tone, the last two are guttural. The single *peek* note uttered by *magna* when its suspicions have been aroused and it is about to fly, was not heard from the Cuban bird.

A comparison of this humble vocal effort with the lauded melody of the Western Meadowlark (*S. m. neglecta*) presents a remarkable range of variation in song power between birds which are ranked as subspecifically related.

During the ride referred to I also observed in *Sturnella* what appears to be an instance of its appreciation of the value of protective coloration. Many birds were seen perching on the fences by the roadside. With one exception these birds did not permit me to see their breasts, but turned their backs as they alighted near me or on my too close approach, and then watched me from over their shoulders. The exception may with truth be said to have proved the rule, for in this instance *Sturnella* chose the lesser of two evils, and presented his brilliant yellow breast to me, while the inconspicuous brownish back was turned toward a Marsh Hawk which was coursing over the field on the other side of the fence on which the Meadowlark was resting. Having my attention thus early attracted to this interesting trait I closely watched *Sturnella* during the following two weeks, but on no occasion did it fail to turn its back on me when I had approached to within what it considered an unsafe distance.

Fifteen specimens show both the winter and more worn breeding plumage; seven have the bluish-black bill of breeding birds. Comparison of this series with a large number of Meadowlarks shows unexpectedly that the Cuban birds are far more closely related to *Sturnella neglecta* than to any other form of the genus. Indeed, the differences which distinguish *hippocrepis* from *neglecta* consist largely in the smaller size and darker coloration of the former, but in pattern of coloration there is little difference between the Cuban and Western birds. When we consider that Floridan and Mexican birds very closely resemble each other, and represent the extreme of variation from *neglecta*, it is surprising that the Cuban bird should be more closely related to the latter than to either of the former. The relationship, too, brings into more marked contrast the differences which exist between the songs of the two birds.

69. **Icterus hypomelas** (*Bonap.*). SOLIBIO. CUBAN ORIOLE.— A common species, reminding me, in its flight and habits, of the Orchard Oriole (*Icterus spurius*). Their food seemed to consist largely of insects, which they obtained from the blossoms of flowering trees and plants, that of the banana being an especial favorite. As a result of this habit their heads and necks were frequently well-dusted with pollen, which showed conspicuously on their black plumage, and in some specimens persists as a permanent stain. Their song is weak but sweet and plaintive, and suggestive of that of a far-away Meadowlark (*Sturnella magna*). The single call-note was so like the metallic flight-note of the

English Sparrow that to one familiar with the haunts and character of the latter bird it was strikingly incongruous.

As in the case of several other Cuban species, these birds were almost always seen in pairs, or, on occasions, two pairs would be seen together. I was soon struck by the fact, to which I noted no exception, that these pairs were composed of birds of the same apparent age, that is adult black and yellow birds were mated with birds in the same plumage, while immature birds had immature mates.

One individual of this species, captured after being slightly winged, won my admiration by his fearless behavior. As I held him perched upon my finger, he divided his time between vigorously biting my hand and singing, thus giving a fine illustration of song as a result of excitement.

In a series of twenty-five specimens twelve are males and thirteen females. Sixteen are in the black and yellow plumage of the adult bird. Seven of these are males and eight females. Beyond a slight difference in size, the males being larger, the sexes are indistinguishable. The remaining nine birds have black throats, and the plumage is more or less mottled with black. They are evidently birds of the previous year, and would require one more year in which to complete their plumage.

70. Quiscalus gundlachi *Cass.* CHICHINGUACO. CUBAN GRACKLE.—An abundant and conspicuous species, giving character to the avifauna more than any other bird. It is not, however, found in the towns, as is the Great-tailed Grackle in Texas. It has an extended vocabulary of whistled notes and indescribable calls, and is very noisy. While these notes were unmistakably Quiscaline, I could detect no exact resemblance to the calls of either *Q. macrourus*, *major* or *quiscula*. In vocal ability I should rank the Cuban bird between *macrourus* and *major*.

In the males the tail is permanently keeled, that is, is wedge-shaped even when the bird is at rest. In flying it is expanded vertically, and measures from four to five inches in depth at the tip. This gives them a most ludicrous appearance, which is heightened by their fluttering, labored flight. Indeed, when on the wing they resemble miniature flying machines. These birds were particularly abundant about my home in the San Juan Mountains, where they were attracted by the ripe corn in the clearing of a neighboring mountaineer. They passed the greater part of the day feeding on this dainty, but in the early afternoon, as the shadows came into the valley, they all flew, with much fluttering and calling, into the palms at the border of the clearing. Here they fed on the palm berries, passing from tree to tree up the slope of the mountain, following the fast waning light, until finally the sun set, and they roosted where darkness found them.

71. **Ptiloxena** (gen. nov.) **atroviolaceus** (*d'Orb.*). Toti.—Abundant. Though frequently found with *Quiscalus gundlachi*, the birds were brought together through a fondness for the same kind of food, and were not in any other sense associated. Indeed, the bird does not resemble a Grackle in either flight or notes. It has a number of calls, the most common of which reminded me of the *peto, peto*, of the Tufted Titmouse. In April I saw them carrying nesting material into the palm trees.

Different authors have referred this bird to the genera *Quiscalus*, *Scolecophagus* and *Dives*. It is evidently more closely related to the last, in which recent authors place it. It differs from *Dives*, however, in several important structural details. In *Dives* the first primary is equal to the eighth, and the third to sixth are subequal; in *atroviolaceus* the first primary is longer than the sixth, and the second to fifth are subequal. *Dives* has a more rounded tail than the Cuban bird; in the latter the outer tail-feather is but a quarter of an inch shorter than the middle pair, while in the former the outer tail-feather is three-quarters of an inch the shorter. There is also a slight difference in the shape of the bill, which in *atroviolaceus* is shorter, stouter, and with a more convex culmen than in *Dives*. The most striking difference between the two, however, is in the structure of the contour feathers of the fore parts of the body, especially those of the breast.

In *atroviolaceus* the barbicels, while apparently of the normal number, are fasciculate, and, except at its basal third, adhere to the barb. For the terminal half of the feather, therefore, the barbs have no connection with one another, and this gives to the

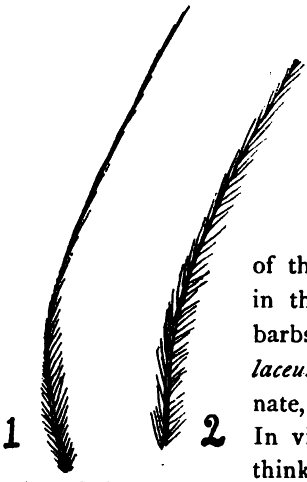

Fig. 1. Barb from a breast feather of *Ptiloxena*. Enlarged.
Fig. 2. Barb of *Dives sumichrasti*. Enlarged.

parts in which these feathers grow a finely streaked, hairy appearance. To some extent this peculiar structure is shown by the West Indian *Quiscali* of the Subgenus *Holoquiscalus*. In *Dives*, however, and the continental *Quiscali*, the structure of the feathers is normal, and, as shown in the accompanying cuts representing barbs from the feathers of both *atroviolaceus* and *Dives*, the barbicels are pennate, and branch out from the barb. In view of these structural differences I think *atroviolaceus* should be placed in a new genus, for which I propose the name *Ptiloxena*.

72. Ammodramus savannarum passerinus (*Wils.*). GRASSHOPPER SPARROW.—Common at San Pablo, and not uncommon at Guanayara.

Comparison of six specimens of true *savannarum* from Jamaica with a series of *passerinus* from the eastern United States fails to show any constant difference in color which would serve to distinguish these forms. The Jamaican birds average slightly darker, and are without the streakings on the breast found in many North American specimens. In size, however, the Jamaican birds are smaller than United States specimens. Of thirteen specimens from near Trinidad five are without streakings on the breast, but none are as small as the largest Jamaican specimen.

The appended measurements show that they belong to the northern rather than the southern form. Probably they were winter visitants, for Dr. Gundlach says the bird does not breed on the island.

	Wing.	*Tail.*
Jamaica, six specimens	2.24	1.54
Cuba, thirteen "	2.39	1.70
New York, six "	2.42	1.74

73. Euethia canora (*Gmel.*). TOMEGUIN DEL PINAR.—Not uncommon.

74. **Euethia lepida** (*Jacq.*). Tomeguin de la Tierra.—Very common in small flocks, which pass much of their time on the ground. Their song is a not unmusical weak trill.

75. **Passerina cyanea** (*Linn.*). "Azulejo." Indigo Bunting.—An adult male seen March 18.

76. **Melopyrrha nigra** (*Linn.*). Negrito.—A common species frequenting bushes and undergrowth. They commenced to nest about March 11. With *Euethia canora* this is one of the favorite cage-birds among the natives. Its song, however, is only a weak warble.

77. **Spindalis pretrei** (*Less.*). Cabrero. Cuban Tanager.—Not common. They were generally found in pairs in the woods, and frequented the tops of the trees. Their vocal effort is weak and squeaky and hardly deserves the name of song.

78. **Petrochelidon fulva** (*Vieill.*). Golondrina. Cuban Cliff Swallow.—At San Juan a small flock of these birds occasionally came to the river in the morning to drink, and then disappeared. At San Pablo they were common. One morning a flock of about one hundred was seen to leave a large cave on the bank of a river, and after mounting high in the air scattered in various directions. The cave was inaccessible, and I was unable to determine whether it was used for nesting or roosting.

79. **Vireo calidris barbatula** (*Cab.*). "Predicador." Black-whiskered Vireo.—A summer resident. First observed March 13, and soon became abundant. It is a very tame and unsuspecting bird, and resembles our Red-eyed Vireo both in song and habits. The song, however, is more emphatic and hesitating than that of *V. olivaceus*.

80. **Vireo gundlachi** *Lemb.* Juan Chivi.—Common. This bird has the habits of a White-eyed Vireo, and its song, while quite unlike that of *noveboracensis* is, nevertheless, of the same character. Its iris is light hazel, another character connecting it with the *noveboracensis-crassirostris* group, of which, in spite of its distinctness, it is probably the Cuban representative.

81. **Arbelorhina cyanea** (*Linn.*). "APARCEIDO DE SAN DIEGO."—An immature, molting male, taken at San Pablo while feeding on the fruit of the cupey tree, was the only one seen.

82. **Mniotilta varia** (*Linn.*). BLACK-AND-WHITE WARBLER. —Not uncommon.

North American Warblers which winter in or migrate through Cuba are not recognized by the natives under specific names, but are known by the general name 'Mariposa.'

83. **Compsothlypis americana** (*Linn.*). PARULA WARBLER. —Not uncommon.

84. **Dendroica tigrina** (*Gmel.*). CAPE MAY WARBLER.— Six were observed.

85. **Dendroica petechia** (*Linn.*). "CANARIO DE MANGLAR." CUBAN YELLOW WARBLER.—Observed only at Casilda, where a few were found in or near the mangroves. Their song is easily distinguished from that of *Dendroica æstiva*. Three specimens show that in the adult the crown has a cap of reddish chestnut.

Through the kindness of Mr. Ridgway I have been permitted to examine the National Museum specimens of this group, including Baird's types of *Dendroica petechia gundlachi*. These specimens, four in number, are all in immature plumage, and I think misled Prof. Baird to separate the Cuban from the Jamaican bird. I have seen only six specimens from the latter island, and so far as I am able to judge from this material there are no characters on which birds from the two islands may be separated.

The Bahaman bird, however, which has previously been considered the same as the Cuban species, is apparently a quite distinct race and may stand as

Dendroica petechia flaviceps, subsp. nov.

Chars. Subsp.—Smaller and more yellow than any bird in the group, and as a rule without a well-defined crown cap.

Description of Type (No. 39,848, Am. Mus. Nat. Hist. Adult male, Rum Cay, Bahamas, March 4, 1886. Collected by the naturalists of the Fish Commission Steamer 'Albatross.' U. S. Nat. Mus. No. 108,076).—Above greenish yellow, the crown yellower and with traces of concealed rufous; wings externally brownish black, the quills margined with yellow externally and with their coverts heavily margined externally with the color of the back; tail dark greenish brown, the inner webs of the feathers, except the middle pair, entirely yellow except at the tip and a narrow strip along the vane; underparts rich yellow, the breast and sides streaked with rufous. Wing, 2.38; tail, 1.98; bill, .41 in.

Of this new race I have examined a series of twenty-one adult males from Rum Cay, New Providence, Conception, Wattling, Eleuthera and Cat Islands, taken by the same collectors in March, 1886. In nine of the twenty-one the rufous of the head, while not clearly defined, is at once evident; in the remaining twelve the head is apparently but slightly yellower than the back, but on closer examination the feathers are found to have small brownish centres or shaft streaks. The most highly-developed birds of the nine have the brownish centres larger and showing through the greenish yellow tips of the feathers. Doubtless in more worn plumage these yellowish tips would disappear, and in three birds from Conception and Wattling Islands there would remain sufficient brown to form a cap similar to that seen in Jamaican and Cuban specimens. The smaller size of the Bahaman bird is shown by the following average measurements: Nine males from Rum Cay: wing, 2.40; tail, 2.01; bill, .40 in. Three males from Cuba: wing, 2.56; tail, 2.07; bill, .40 in. Five males from Jamaica: wing, 2.59; tail, 2.12; bill, .40 in. Two males from Grand Cayman: wing, 2.54; tail, 2.05; bill, .40 in.

86. **Dendroica cærulescens** (*Gmel.*). BLACK-THROATED BLUE WARBLER.—Both sexes were very common.

87. **Dendroica coronata** (*Linn.*). MYRTLE WARBLER.—Two were observed.

88. **Dendroica dominica** (*Linn.*). YELLOW-THROATED WARBLER.—Two were seen, one of which was secured.

89. **Dendroica palmarum** (*Gmel.*). PALM WARBLER.—Exceedingly common. I saw no specimens of *hypochrysea*, which is easily distinguishable from *palmarum* in the field.

90. **Dendroica discolor** (*Vieill.*). PRAIRIE WARBLER.—Common.

91. **Seiurus aurocapillus** (*Linn.*). Oven-bird.—Not uncommon.

92. **Seiurus motacilla** (*Vieill.*). Louisiana Water-thrush. —Not uncommon.

93. **Geothlypis trichas** (*Linn.*). Maryland Yellow-throat.—Not uncommon.

94. **Setophaga ruticilla** (*Linn.*). American Redstart.—Common.

95. **Mimus polyglottos** (*Linn.*). Sinsonte. Mocking-bird.—Two birds, one of which was singing, were seen on the south slope of the coast range near Trinidad. They are not common anywhere, and are unknown away from the immediate vicinity of the coast.

96. **Galeoscoptes carolinensis** (*Linn.*). Sinsonte Gato. Catbird.—Common, but not in song.

97. **Polioptila cærulea** (*Linn.*). "Rabuita." Blue-gray Gnatcatcher.—Five were seen, of which two were secured. I have not compared them with *P. c. cæsiogaster*, of which I have no specimens.

98. **Polioptila lembeyi** (*Gundl.*). "Sinsontillo."—One specimen was secured at Casilda. It was singing a song which resembled that of *P. cærulea*, but it possessed greater volume and sweetness.

99. **Mimocichla rubripes** (*Temm.*). Zorzal. Cuban Robin.—An abundant species, reminding me strongly in some of its habits of our Robin (*Merula migratoria*). It was, however, an inhabitant of the lower growth, but still, like the Robin, it frequented the clearings, hopping a yard or so, then stopping, raising and lowering its tail in a pensive kind of way. At times it flew into the higher branches of the trees to sing. Its song is a weak, unmusical performance, curiously suggestive of a young Robin's first attempts, while the manner of singing is somewhat disconnected, as though the bird sang with an effort. A common and very singular call-note resembled the cry uttered by an

adult Robin when held captive and presumably greatly alarmed or in pain, but *Mimocichla* utters this call when alone and under no excitement whatever.

As a rule these birds were seen in pairs, and though evidently mated they showed no signs of breeding.

There is remarkably little sexual or individual variation among nineteen specimens collected in the mountains and in the valley, and all are typical of *rubripes*. *M. schistacea* is apparently confined to the eastern part of the island but the differences which distinguish it from *rubripes* are so slight that they doubtless intergrade as their habitats approach each other.

II.—Notes on Mammals Observed.

According to Dr. Gundlach (Cont. Mamalogia Cubana, Havana, 1877), there are found in Cuba three species of *Capromys*, one of *Solenodon*, and nineteen species of Bats.

The Solenodont is apparently unknown near Trinidad. Of Bats, one sees only the insect-feeding species coursing in the open, while the fruit-eating species are confined to the woods. Shortly before leaving San Juan I found that a long, narrow tract of woods at the base of the mountain was the nightly highway of immense numbers of Bats. They rushed through here in a continuous flight, flying from within a few feet of the ground to a height level with the tree tops. They were doubtless of several species, but I did not succeed in finding the cave or caves from which they proceeded.

1. **Mus tectorum** *Savi.* Rata. Roof Rat.—Abundant. I found this Rat inhabiting remote caves in the mountains where it was feeding on wild fruits, and was evidently quite independent of man. I saw neither *Mus rattus* nor *M. decumanus*.

2. **Mus musculus** *Linn.* "Ratoncito." House Mouse.—Abundant. In disintegrated Barn Owl pellets, secured in a cave, I found the remains of twenty-five House Mice and one Rat. The absence of the remains of other small Rodents is evidence pointing towards their absence from the island.

3. **Capromys pilorides** *Say.* Hutia Conga.—A common animal in the mountains and foot-hills where it lives among the rocks. It passes the day in concealment, generally in one of the innumerable holes among the rocks, and comes out at night to feed. At the time of my visit it was feeding on the 'guasima,' a small, round, green, nut-like fruit, which grew in abundance in trees about twenty feet in height. It is arboreal, and obtains this fruit by climbing the trees for it. It climbs slowly, but passes along limbs having a diameter of not more than one and a half inches with ease. It sometimes passes the day in a tree, choosing one with a rich growth of parasitic plants among which it conceals itself.

The largest of three specimens is an adult female, which contained four small embryos, and measured: total length, 31.88; tail, 8.07; hind foot, 3.93; fore foot, 2.44; greatest girth, 3.46 in.

The Hutia Mono (*Capromys prehensilis*) was reported to me by the natives, who said it was much rarer than Hutia Conga.

4. **Capromys columbianus,** sp. nov.

Based on a portion of a semi-fossil skull, showing the malar and alveolar portion of the maxillary of the right side, one upper molar, the anterior portion of the palate and anterior two-thirds of the inner border of the molar alveoli of the left side.

This fragment of the skull, of which a figure is presented,[1] belongs to a species of *Capromys*, slightly smaller than fully adult specimens of *Capromys pilorides*, but differing decidedly from any known species of the group.

Fig. 3. Portion of the skull of *Capromys columbianus.* Nat. size.

In *pilorides* the space between the inner borders of the alveoli at the anterior margin of the upper premolar is .21 in.;[2] in *columbianus* the space between the same parts at the anterior margin of the first molar is but .04 in., and the alveoli would

[1] Compare with a figure of the inferior surface of the skull of *Capromys ingrahami*, this Bulletin, III, 1891, p. 335.

[2] *Cf.* also Dobson, P. Z. S., 1884, p. 235, where measurements of the skulls of four species are given.

apparently meet between the premolars. The malar portion of the maxillary is much expanded in *columbianus*, and at its base extends from a point opposite the first internal loop in the exterior margin of the premolar to the maxillo-premaxillary suture, and its inferior face is more deeply sulcate than in that of *pilorides*. The molar is either the first or second of the right upper series. The enamel pattern is somewhat different from that of *pilorides*, but the folds bear the same relationships to one another as do those in the molars of *pilorides*.

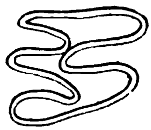

Fig. 4. Right upper molar of *Capromys columbianus*. About three times nat. size.

This portion of the skull was found in a cave near Trinidad, associated with remains of bats and birds, and also fragmentary pieces of the bones of *Capromys* of perhaps the same species as the one described.

The cave is situated in the southern slope of the coral limestone coast range at an altitude of about seven hundred feet, and within two hundred feet of the summit of this part of the range. Imbedded in the conglomerate walls of this cave were numerous shells, some of which I collected and have submitted to Prof. Whitfield, who has identified them with living species. This fact, in connection with its coralline structure, shows the cave to be of recent, doubtless Quaternary, formation.

The floor of the cave was covered to the depth of several feet with a red, ferruginous earth, and on this was a layer four or five inches in depth of a dark earth in which the bones mentioned were found.

The Hutia, as the native West Indians called the various species of *Capromys*, is the first animal mentioned from the New World by Columbus. Being almost the only edible quadruped, it formed an important part of the fare of the early colonists, and on the shores of South Cuba, in the then Province of Ornofai, perhaps within sight of the cave just described, Columbus landed with his crew and was feasted by the natives on the flesh of the Hutia. It seems eminently proper, therefore, to connect his name with the genus.

5. Vesperugo fuscus cubensis (*Gray*).

Scotophilus cubensis GRAY, Ann. Nat. Hist. IV, 1839, p. 7.
Vesperus dutertreus GUNDL. Cont. Mamalogia Cubana, Havana, 1877, p. 32.
Vesperugo serotinus Var. β. (Vesperus fuscus) DOBSON, Cat. Chiropt. 1878, p. 193 (Cuban references only).
Vesperugo fuscus J. A. ALLEN, Bull. Am. Mus. Nat. Hist. III, 1890, p. 169 (Bahamas).

The Brown Bat is a common species in Cuba, and with other purely insectivorous species was seen nightly coursing for food. Fourteen individuals found hanging together on the wall of a limestone cave proved to be all females.

These specimens are not smaller than examples of *fuscus* from North America, but, like the specimen described by Dr. Allen from the Bahamas, the ears and wing membranes are thinner than in North American specimens, and the former are slightly narrower and more pointed. These differences appear to be constant, and I think render the Cuban Brown Bat worthy of recognition as a race.

6. **Atalapha noveboracensis pfeifferi** (*Gundl.*).—Apparently not common. Two intensely colored specimens, both males, were secured. They are of the same size and show that, as has been claimed, the Cuban Red Bat is slightly larger than the North American *noveboracensis*. I do not observe, however, that the premolar is larger in the Cuban form, as has been claimed. The measurements of the two specimens are as follows: forearm, 1.71; third finger, 3.48; tibia, .90 in. North American specimens average: forearm, 1.60; third finger, 3.20; tibia, .87 in.

7. **Nyctinomus brasiliensis** *Is. Geoffroy.*—Common. Just after sunset, on March 17, thousands of these Bats were seen flying to the westward. On no other occasion were they seen in anything like the same numbers.

8. **Phyllonicterus poeyi** *Gundl.*—This species was not met with alive, and is included on the basis of two skulls found in the stomach of a Barn Owl.

9. **Artibeus perspicillatus** (*Linn.*).—Exceedingly abundant. This was found to be the common Cave-bat; indeed, was the only one which I succeeded in finding in numbers.

At San Pablo I visited a cave consisting of a series of chambers opening one into the other or to the surface, which were inhabited by these Bats in countless thousands. On arriving, a few were seen hanging in clusters from the rounded depressions which dotted the roofs of the chambers. It was light here, and on seeing us the Bats took wing, flitting about from cave to cave in search of new resting places. Finally we discovered a nearly dark chamber about seventy-five feet in diameter, and with walls twenty feet in height, with only two small openings. The moment we entered there was a rush of wings, sounding like the wind through trees; we could catch glimpses of many Bats, while a steady stream of them poured from the two openings. Bringing dead palm leaves we used them as torches, and their light revealed a wonderful sight. The white limestone roof of the cave was patched and streaked with hanging Bats, which in lines, bunches and large solid masses covered at least half its surface, while over our heads an incalculable swarm was circling to and fro. They were apparently all adults of one species. The floor of the cave was covered with the remains of fruit, which was mostly of the kind known as 'guasima.' Of fifty-six Bats taken at this cave twenty-four are males, and thirty-two females. Eighteen of the females contained one embryo each. All these Bats were infested by a small parsitic fly and spider.

Taken as a whole this series is quite constant in coloration, but comparison of the extremes shows, nevertheless, a wide range of variation in color. The underparts in the average specimen are light brown, with the hairs all tipped with white. In one extreme the color is much paler, almost grayish white, in the other the underparts are of a darker brown than the average, the hairs scarcely, if at all, tipped with white. There is less variation in the color of the back, which is usually of a light seal brown. The facial streaks are nearly obsolete, and in many specimens entirely wanting. There is apparently little sexual variation in either color or size.

This Bat is, of course, not true *perspicillata* but in the absence of material for comparison, I cannot determine to which of the numerous forms of this group it should be referred.

III.—Remarks on the Origin of West Indian Bird-Life.[1]

The marked peculiarities exhibited by the fauna of the West Indies have long claimed the attention of zoölogists. The proximity of the group to the mainland, the inter-relationships of the islands, the distinctness of some West Indian species, the evident relationships of others, combine to present problems of unusual interest to the student of island-life. At the same time the physical changes to which the islands have been subjected, their past probable connection with one another and with the mainland, render a study of the origin of their life far more complicated than in the case of purely oceanic islands.

In 1876, when Wallace wrote on the West Indian fauna (Distribution of Animals), he presented a table of 203 species of resident land-birds which had been recorded from this region. Since that date, largely through the efforts of Mr. C. B. Cory, Mr. Lawrence's reports on Ober's collections, and Mr. Ridgway's reports on material collected by the naturalists of the Fish Commission, our knowledge of the West Indian avifauna has been so augmented that the known number of resident land-birds is now considerably over 300. In addition to this increase in our knowledge of the avifauna we have, through the cruises made by vessels of the Fish Commission, more accurate and detailed information regarding the topography of the Caribbean basin. This has been well summarized by Prof. A. Agassiz in his 'Three Cruises of the Blake.' With the added assistance derived from these later works we may briefly review the bird and mammal life of the West Indies with particular reference to its bearing on a past connection of the islands with the Central American mainland.

Some 550 species and subspecies of birds have now been recorded from the West Indies. Of these no less than 303 are endemic, while the remaining 248 may be allotted according to

[1] Read before the American Ornithologists' Union, Tenth Congress, Washington D. C., Nov. 15-17, 1892.

the regions from which they apparently have been derived, as follows:

Continental	16
Tropical	56
South American	13
Central American	3
North American	160

The first, or Continental, includes species of more or less general distribution throughout both North and South America. Five are land-birds and eleven water-birds. The second, or Tropical, includes species of general distribution in the tropics. Many of these reach the southern border of the United States, and some are found throughout the Tropical Realm. Eighteen are land-birds and thirty-eight water-birds. Of the third, or South American group, ten, all of which are land-birds, are found in only the Windward Islands, while the three which occur in the Greater Antilles are water-birds. Of the three Central American or Mexican species, one is a Swift (*Cypseloides niger*), one a Duck (*Dendrocygna autumnalis*), and the third (*Icterus cucullatus*) has been recorded only from Cuba, where it has been found but once. The fifth, or North American group, consists of birds which pass the nesting season in North America and, with few exceptions, occur in the West Indies only during the winter or while on their migrations. Eighty-nine are land-birds and seventy water-birds. As Prof. Baird has shown,[1] they are all birds of eastern North America which enter the West Indies through Florida. Cuba, therefore, receives by far the larger share. While a study of this later and migratory life will, in some instances, show us the sources from which the more recent West Indian species have been derived, it will not aid in determining the origin of the more distinct species which may have become West Indian under physiographic conditions not now prevailing. It is only by a study of the endemic species that we may hope to gain some understanding of the past history of the islands. As already stated, 302 species are endemic. Some of these reach the neighboring mainlands, as, for example, southern

[1] Am. Journ. Sci. and Arts, XLI, 1866, p. 18.

Florida; but they are none the less truly West Indian. Of the number mentioned only nine are water-birds. This leaves 293 land-birds as peculiar, or about 90 per cent. of the resident land-bird life. Considering how near the islands are to the mainland this is certainly a remarkable degree of specialization.

The Relationships of the Greater to the Lesser Antilles.—The more distinct and characteristic West Indian species are found in the Greater Antilles. While in some instances, *e. g.*, *Myiadestes* and *Quiscalus*, certain West Indian forms are developed in both the Greater and Lesser Antilles, it is evident that the zoölogical relationships between the two regions are comparatively recent and, as Wallace has said, they may be divided into "two very different groups" (Distrib. Animals, Am. Ed., II., p. 62). Wallace, however, drew his dividing line "immediately south of St. Croix and St. Bartholomew," thus placing these islands, with St. Martin, Anguilla and Sombrero, in the Greater Antilles. But, as Prof. Agassiz has shown (Three Cruises of the Blake, II, p. 112), with the exception of St. Croix, these islands are enclosed by the 500-fathom line which, except for the more eastward Barbadoes and a narrow channel north and south of Martinique, unites the chain of Windward Islands with South America. To the westward the Anguilla group is separated from the Virgin Islands by the Anegada Channel, having a depth of from 1000 to 1600 fathoms. The position of St. Croix cannot perhaps be definitely determined. Its faunal affinities are with Porto Rico, to which it is connected by "a submarine ridge with a depth of about 900 fathoms" (Agassiz, l. c.), while to the eastward it is separated from the Saba Bank by a ridge having a not greater depth than 800 fathoms. Cleve (Annals N. Y. Lyceum, 1881, p. 189) states that St. Croix belongs geologically to the Virgin Islands, and remarks: "The large West Indian Islands contain, then, ridges of raised Cretaceous rocks and the Virgin Islands form their eastern outcrops. South of the Virgin Islands they are not met with except in Trinidad." Thus Anguilla, which, according to the same author, is entirely of Miocene formation, is placed with the Lesser Antilles. Its position is of importance, for from the bone caves of this island Cope has described the only fossil mammalia which, so far as I am aware, have been found in the West Indies (excepting the *Capromys* described in the present paper). These remains, consisting of detached teeth and fragmentary bones, are considered as related to the South American Chinchillas.

It is evident then that, as Prof. Agassiz remarks (l. c., p. 113, footnote), "the Windward Islands were probably raised long after the range of the greater West Indian Islands existed...." In analyzing their avifauna, therefore, I shall treat of the two as separate regions. As might be expected, there has been an interchange of life between these two groups; certain Lesser Antillean genera, *e. g.*, *Margarops* and *Bellona*, extend northward into the more eastern Greater Antilles, and the larger islands have in some instances contributed to the life of the smaller, as in the case of a species of *Mimocichla* found in Dominica. Again, some genera have a continuous range from South America through the Antilles to Central America. But it is evident that the zoölogical influence of the Lesser on the Greater Antilles is of comparatively late date, and has no primary bearing on the origin of the older forms which characterize the last-named group.

Our inquiry lies more with the older islands, but before treating of them we may briefly review the avifauna of the Windward group.

The Lesser Antilles.—About 108 resident land-birds are known from the Lesser Antilles. Of these thirteen are South American, of which ten are West Indian only as they occur in the Lesser Antilles, and fourteen are West Indian species which have a continuous West Indian distribution. This leaves us with eighty-one land-birds as peculiar to the group. *Fulica caribæa*, the only peculiar water-bird, doubtless has a wider range than we are at present aware of. Eight genera are peculiar. Two of these, *Margarops* and *Bellona*, send each a species into the eastern Greater Antilles, but they are none the less distinctively Lesser Antillean. Excluding the two species just referred to, these eight genera contain seventeen species. Subtracting these from the eighty-one endemic land-birds we have left sixty-four species. These may be divided, according to their relationships, as follows:

Tropical	22
South American	19
West Indian	23

The first includes localized forms of wide-ranging tropical species; the second is composed of species obviously derived from South American ancestors, *e. g.*, *Merula*, *Thryothorus*, *Calliste* and *Saltator*. The third contains species belonging to groups or genera which are now West Indian, though it is not improbable that some of them may originally have been derived from South America through the Lesser Antilles.

A comparison of the fauna of Trinidad, Tobago and Grenada, the most southern of the Antillean chain, will show more clearly the nature of the South American element in the Lesser Antilles. Omitting migrants and species of general distribution, some 150 land-birds are given from Trinidad by Léotaud. Of these about fifty-four are recorded by Jardine[1] from Tobago, which is distant twenty miles from Trinidad. With the exception of the very slightly differentiated *Troglodytes tobagensis* and the doubtfully distinct *Amazilia tobaci*, Tobago has no species not found in Trinidad, while the fifty-four species mentioned include representatives of such local and non-migratory families as Pipridæ, Momotidæ, Galbulidæ, Dendrocolaptidæ and Formicariidæ, thus strongly indicating a previous land connection with Trinidad.

From Wells's list of Grenada birds[2] we learn that of the 150 Trinidad species of which, as just stated, fifty-four reach Tobago, only fifteen appear or are represented by close allies in Grenada. None of the sedentary families mentioned as occurring in Trinidad and Tobago are found in Grenada, and with the exception of one species each of *Thryothorus*, *Calliste*, *Saltator* and *Spermophila*, the genera of Grenada have a more or less extended West Indian range. On the other hand Grenada has eight species not found in Trinadad. Grenada is seventy-five miles

[1] Ann. and Mag. Nat. Hist., XVIII, 1846, p. 114, et seq.
[2] Proc. U. S. Nat. Mus., 1886, p. 609.

from Trinidad, and the difference which we have seen to exist in their avifauna is such as might under the present conditions be expected. It would seem, therefore, that since the appearance of the present fauna no connection has existed between this island and the mainland. If we except the fossil remains found on Anguilla, and the possibly unassisted presence of a now apparently distinct Agouti (*Dasyprocta cristata*), this view is supported by the absence of terrestrial mammalia, excluding those whose introduction is due to man's agency.

The Greater Antilles.—In a previous paper (Am. Nat., 1891, pp. 528–539) I have given reasons for believing that the Bahamas are zoölogical dependencies of the surrounding mainland and islands, from which their avifauna has been derived.

Grand Cayman, with its fifteen peculiar forms, showing relationships largely to Cuban and also to Jamaican species, may perhaps be placed in the same category. This island is situated about 175 miles from Cuba, and 200 miles from Jamaica. It is enclosed by the 1000-fathom line, this depth being reached within a few miles of the shore, while to the north and west it is separated from Cuba and the mainland by 1500 to 2000 fathoms. On the south it is separated from Jamaica by the Bartlett Deep, which has a depth of over 3000 fathoms only twenty miles south of Cayman.

Dr. Sclater has said (Ibis, 1887, p. 125), "Probably the Caymans were mainly stocked with life not by immigration, but when still part of the old Continent out of which the Antilles were carved by the Gulf Stream;" but there is apparently little ground for this belief.

Little Cayman and Cayman Brac, smaller islands, sixty-five miles east of Grand Cayman, from which they are separated by a channel of 1000 fathoms, have, as Mr. Cory has shown (Auk, 1889, p. 30), an avifauna which "is apparently quite different from that of Grand Cayman." They have no peculiar species, and "only five of the resident species of Grand Cayman appear to be found on either of the smaller islands" (Cory, l. c.). Commander Bartlett has remarked of Little Cayman, Grand Cayman, and the Misteriosa Banks to the westward, that they are "the summits, just appearing above tide-mark, of a submarine range of an average height of nearly 20,000 feet" (Three Cruises of the Blake, I, p. 100). We may then regard them as mountain peaks which at different periods have been elevated above the sea. Grand Cayman, with its remarkable number of peculiar forms, is doubtless the oldest, that is, was the first to appear. Little Cayman, with no endemic species, and the Misteriosa Banks probably followed in the order named.

Is it possible that Grand Cayman may once have been connected with Cuba in the direction of the shoal that makes out from Cape Cruz to the westward, but the difference which exists between its avifauna and that of the small Caymans does not confirm this supposition. When we consider also that the avifauna of Grand Cayman is composed of birds having the power of extended flight, and that such abundant but more sedentary Cuban species as *Todus*, *Saurothera* and *Priotelus* are wanting, we may, I think, with some assurance, class it as an oceanic island which has received its bird-life through migration from other islands.

This leaves us with the four islands of the greater Antilles, Jamaica, Cuba, Hayti (under which name I include San Domingo) and Porto Rico. As I have before remarked it is on these islands that the characteristic fauna of the West Indies is developed. There have been recorded from them 174 of the 300 birds peculiar to the West Indies. Of this number 169 are land-birds, and five are water-birds. They are distributed as follows:

Jamaica	66,	of which 42 are endemic.
Cuba	68,	" 45 "
Hayti	56,	" 34 "
Porto Rico	46,	" 25 "

Of the eighty-eight genera to which these birds belong, thirty, containing fifty-four species, are peculiar to the West Indies. They are distributed as follows:

With representatives in four islands	4
" " three "	3
" " two "	2
Peculiar to Jamaica	7
" Cuba	6
" Hayti	7
" Porto Rico	1

It will be observed that although Jamaica is but little larger than Porto Rico, and is more isolated from neighboring regions than any island of the group, it is nearly as rich in endemic species, and has one more peculiar genus than Cuba. The latter island is not only ten times as large as Jamaica, but its proximity to Florida has given it at least four forms which have evidently been derived from Florida species. They are *Colinus virginianus cubanensis*, *Campephilus bairdi*, *Colaptes chrysocaulosus*, and *Sturnella hippocrepis*. Hayti, although about seven times as large as Jamaica, has eight endemic species less, while Porto Rico, nearly as large as Jamaica, and favorably situated for the reception of Lesser Antillean species, has seventeen endemic species less than Jamaica, and but one genus is peculiar to the island.

It is evident that, as Wallace has said, the islands "were not peopled by immigration from surrounding countries while in the condition we now see them, for in that case the smaller and more remote islands would be very much poorer, while Cuba, which is not only the largest, but nearest to the mainland in two directions, would be immensely richer, just as it really is in migratory birds" (Distrib. Animals, Am. Ed., II, p. 66).

These facts in distribution, in connection with a study of hydrographic charts, give us the best clue to a past land connection between the West Indies and the mainland.

From the coast of Honduras and Nicaragua the Mosquito Bank extends northeastward for nearly two hundred miles, or over half the distance from the mainland to Jamaica. It is enclosed by the 100-fathom line, and is divided from the San Pedro Banks by a channel seventy-five miles in width, and having an average depth of 700 fathoms. The San Pedro Banks, some of which appear above the surface of the sea, while none are below twenty-five fathoms, reach to within thirty miles of the south shore of Jamaica, from which they are separated by a channel having a depth of 600 to 900 fathoms. An elevation therefore of 100 fathoms would leave only two channels, the wider seventy-five miles, between Jamaica and the mainland.

Wallace advances the theory of a complete land connection between Jamaica and Central America, and also between Cuba and Yucatan, and suggests the probability of an ancient land in the area enclosed by these connections. This view, as we have seen, is supported by Dr. Sclater, who has proposed for this hypothetical region the name 'Præantillesia.' Recent soundings, however, tend to disprove this theory.

In this connection Prof. Agassiz remarks: "The deep soundings (over three thousand fathoms) developed by the 'Blake' south of Cuba, between that island and Yucatan and Jamaica, do not lend much support to the theory of an Antillean continent, as mapped out by Wallace, nor is it probable that this continent had a much greater extension in former times than now, judging from the depths found on both sides of the West Indian Islands" (l. c., p. 116).

While there is little ground, therefore, for the hypothesis of an Antillean continent, it is not impossible that the land connection I have just outlined between Central America and Jamaica may have existed. That there has been a closer connection between this island and the mainland both the disproportionately rich avifauna of Jamaica and the shallowness of the intervening sea give us good reason to believe, but that the island has ever been completely joined to the mainland there is abundant room for doubt; first, because of the scarcity of terrestrial mammalia in the West Indies; second, because of the restrictions of the avifauna.

The land mammals of the West Indies, exclusive of Bats, are included in the three genera *Solenodon*, *Plagiodontia* and *Capromys*. *Solenodon*, with a single species each in Hayti and Cuba, is remarkable as having its nearest relationships with *Centetes* of Madagascar. *Plagiodontia*, with one species in Hayti, is nearly allied to *Capromys*. *Capromys*, with five or six species, finds its nearest ally in *Dasysprocta*, which ranges from Mexico southward. Cuba has three species of *Capromys*, the Bahamas one, Jamaica one, and Swan Island one, Porto Rico being without a representative of the group. The recent discovery on Swan Island by Mr. C. H. Townsend of a species of *Capromys*, differing but slightly if at all from the Jamaican species, points strongly towards the former extension of land in this direction. Swan Island is about one hundred miles from the coast of Honduras, and sixty miles north of the Mosquito Bank, which reaches out towards Jamaica.

Our knowledge of West Indian Bats is as yet very incomplete. Comparison of Gundlach's lists of Cuban and Porto Rican species with Osborne's list of Jamaican species (using Dr. Dobson's determinations), results as follows: Of a total of nineteen species three are evidently of North American origin, and are recorded only from Cuba; seven are tropical, and nine are West Indian. Of fourteen genera four are West Indian. All the nine West Indian species have been found in Cuba, six have been recorded from Jamaica, and two from Porto Rico. This serves to emphasize the isolation of Porto Rico, and the richness of the Jamaican fauna as compared with the size of the island.

The discovery of the remains of extinct mammals on Anguilla is considered by Mr. Wallace as strong evidence in favor of a former Antillean continent, and he remarks that further exploration will undoubtedly result in the discovery of additional remains of extinct mammalia. We have seen that with little doubt Anguilla is a member of the Lesser Antilles, and has had no connection with the larger islands. The remains found there have, therefore, apparently no bearing on the present case.

The sixteen years which have elapsed since the publication of Mr. Wallace's work have not added to our recorded knowledge of the mammalian palæontology of the West Indies. While it is true there has been no direct search for fossil mammals, the fossil molluscan fauna has received the attention of eminent conchologists who have not reported the discovery of mammalian remains. That islands so well adapted to the support of a rich mammal fauna should be so poor in representatives of this class, is one of the strongest zoölogical arguments opposing a past continental connection. Comparison of the West Indian fâuna, with the life of continental islands, presents a striking contrast. For example, Formosa, ninety miles from the mainland, and about one-fourth the size of Cuba, has, according to Wallace, no less than thirty-one species of terrestrial mammalia, including representatives of *Ursus*, *Felis*, *Sus*, *Cervus* and *Bos*.

Mr. Wallace accounts for the comparative absence of mammals in the West Indies by subsidence, which has greatly reduced the extent of the land. That there have been periods of subsidence in the West Indies is a geological fact. That the submergence has been on so grand a scale as to result in the "almost complete annihilation of the mammalian fauna," does not, in view of the extensive development of older formations showing no traces of marine deposits, seem probable. Nor is it likely that in each island so defenseless an animal as *Capromys* would be almost the sole surviving species.

The absence from the West Indies of representatives of many families of birds found on the mainland is also evidence opposed to the theory of a past connection between these islands and the continent. With the exception of *Hadrostomus niger* on Jamaica, and *Colinus virginianus cubanensis* on Cuba, the following twelve families, all of which are found from Mexico southward, are without representatives in the larger West Indian Islands.

Troglodytidæ.	Formicariidæ.	Ramphastidæ.
Pipridæ.	Galbulidæ.	Cracidæ.
Cotingidæ.	Bucconidæ.	Tetraonidæ.
Dendrocolaptidæ.	Momotidæ.	Tinamidæ.

Examination of Zeledon's list of Costa Rican birds shows that in Costa Rica there are found no less than 140 species belonging to these families.

It is a significant fact that almost all these birds are either terrestrial or of sedentary habits. That is, they are birds which we should not expect to find occupying a prominent place in an insular avifauna. Their absence from the West Indies cannot with reason be attributed to subsidence, and is, therefore, a fact which must be explained before the theory of a continental connection can be accepted.

Summarizing this brief review of the more striking features of the West Indian fauna, we have, from the standpoint of birds and mammals, the following facts bearing on the question of a past connection between these islands and the mainland. In favor of this theory are, (1) the disproportionately rich fauna of Jamaica; (2) the shallow sea between this island and the mainland; (3) the West Indian affinities of Swan Island as shown by the presence of *Capromys*. Opposed to the theory of a land connection are, (1) the scarcity of land mammals; (2) the absence of representatives of many families of birds found on the mainland.

It seems to me, however, that these facts may be harmonized and made to support one another if we can show a reason for the belief, that if a connection existed between Jamaica and the Mosquito coast, it was at a time when the latter region was perhaps itself separated from the mainland by passages connecting the Pacific with the Caribbean Sea. Of such passages, Prof. Agassiz has said, "we find traces in the Tertiary and Cretaceous deposits of the Isthmus of Darien, of Panama, and of Nicaraugua" (Three Cruises of the Blake, I, p. 113).

The same author continues: "Central America and northern South America at that time must have been a series of large islands with passages leading between them from the Pacific into the Caribbean." If this supposition be correct, it is quite possible that the families of birds which we have seen are not represented in the West Indies were not at that time found in Central America, and that they have appeared there only since the land connection with South America has been formed. Previous to this time, however, the West Indies had become detached.

This view is supported by the fact that of the twelve families of birds named all but the *Troglodytidæ* and *Tetraonidæ* extend but little north of Southern Mexico. And further, with the two exceptions noted, the Central American and Mexican representatives of these families are in many instances co-specific with the South American forms, and but few peculiar genera have been developed north of the Isthmus. This would seem to indicate the recent appearance of these birds in this region. On the other hand the families to which the endemic West Indian birds belong are represented in Mexico and Central America by many peculiar genera.

In accordance with this hypothesis we may divide the West Indian fauna into two groups, the first of which was derived during the land connection just suggested, while the second owes its origin to migration, or the more or less fortuitous appearance of birds from surrounding regions. From the nature of the case the line between these two groups cannot be sharply drawn.

Capromys, *Solenodon*, *Mimocichla*, *Spindalis*, *Saurothera* and *Todus*, etc., are representatives of the former, while the slightly differentiated forms of *Mimus*, *Certhiola*, *Myiarchus*, and the close allies of Florida birds found in Cuba, belong to the latter. The fact that many of the older genera have representatives on each of the islands would seem to indicate a past direct or indirect connection between the islands of the group. The generally close relationships which exist between the species of these genera points to the conclusion that they are derived from a common ancestor differing but slightly from the present type.

If we assume that the West Indies were separated sometime during the Middle Tertiary, we may then regard these older forms as survivors of the fauna of that period, which have been preserved to us through the isolation afforded by an insular life. This supposition is supported by the fact that they are quite as distinct from existing genera as are the genera of birds which have been described from the Miocene.

The isolation which has protected these old types has also resulted in the differentiation of the species derived through migration. Thus while the West Indies have preserved to us species which on the mainland have succumbed to the continental struggle for existence, they have given us many new forms which have been differentiated from their mainland ancestors under the influences of a new environment.

Article XVII.—ON A COLLECTION OF BIRDS FROM CHAPADA, MATTO GROSSO, BRAZIL, MADE BY MR. H. H. SMITH.

By JOEL ASAPH ALLEN.

PART II.—TYRANNIDÆ.

(*Continued from Vol. III, p. 380.*)

The present Part treats only of the family Tyrannidæ, which is represented by 45 species. In treating of *Myiarchus tyrannula*, reference is also made to its West Indian, Mexican and United States allies, at one time considered by several ornithologists of repute as merely subspecies of the *M. tyrannula* group.

Since the publication of Part I the Museum has purchased the remainder of the Smith Collection of Chapada birds (see this Bulletin, Vol. III, p. 337), thus increasing the number of duplicates available for exchange.[1]

88. Tænioptera nengeta (*Linn.*).—A series of 59 specimens, divided about equally between males and females, represents every month in the year except October, as follows: January, 4; February, 4; March, 7; April, 9; May, 5; June, 7; July, 4; August, 4; September, 2; October, 0; November, 6; December, 6.

The plumage in the November and December specimens is much faded and worn. The molt begins in December, and the new clothing plumage is pretty well acquired before the end of January, but the molt of the quills continues irregularly till into April. As a rule, however, March and April birds are in good condition, but the highest condition of plumage is seen in the May and June specimens. The females average a little smaller than the males, but there is no very appreciable difference in coloration. By August the plumage begins to show signs of deterioration. In old males the tips of the first and second primaries are more or less incised on the inner vane, but much less so than in some other species of the genus.

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[1] I have learned since the publication of Part I that the credit for gathering and preparing the collection is about equally due to Mrs. H. H. Smith and Mr. W. C. Smith, the latter preparing most of the birds collected during 1883–84.

A bird of the year, in first plumage, taken Dec. 19, has the white of the lower plumage tinged with pale buff, and the gray of the upper plumage with brownish, the rump and upper tail-coverts being decidedly brown; the tips of the wing-coverts are buffy white instead of grayish white.

The measurements of 10 adults of each sex are as follows: *Males:* wing, 5.02–5.68, averaging 5.39; tail, 3.20–3.76, averaging 3.58; culmen, .70–.82, averaging .76. *Females:* wing, 4.90–5.34, averaging 5.19; tail, 3.42–3.74, averaging 3.56; culmen, .70–.80, averaging .75.

89. **Tænioptera velata** (*Licht.*).—Three specimens—Cachoeria, ♂ ad., Feb. 4, 1886; Chapada, ♂ ad., Sept. 23, 1883, ♀ ad., Dec. 6, 1883.

90. **Fluvicola albiventris** (*Spix*).—One specimen, Corumba, March 24, 1886.

91. **Arundinicola leucocephala** (*Linn.*).—Four specimens, 2 males and 2 females, Corumba, March, 1886.

92. **Alectrurus tricolor** *Vieill.*—One specimen, ♂, June, 1883.

93. **Cnipolegus comatus** (*Licht.*).—Six specimens, 5 of which are males, taken as follows: January, 1; July, 1; August, 3; October, 1.

94. **Copurus colonus** (*Vieill.*).—Three specimens, November, 1882 and 1883. Two are adults and the other young, in the black plumage=*C. funebris* Cab. & Heine (Mus. Hein., II, 1859, p. 41).

95. **Platyrhynchus bifasciatus** *Allen.*—As already stated (this Bulletin, II, No. 3, 1889, pp. 141, 142) this species is represented by 18 specimens, 11 males and 7 females, all from Chapada. The series having been already fully described (l. c.) further remarks are not necessary.

96. **Todirostrum cinereum** (*Linn.*).—The series of 13 specimens was collected as follows: Chapada, April (2 specimens) and August (5 specimens); Corumba, 6 specimens—February,

March, and April. Of these specimens 7 are sexed as males, 4 as females, and 2 are not marked for sex, but are doubtless females. In all there is a very narrow frontal band of yellow at the base of the bill, in some, however, scarcely discernable. The females are distinguishable from the males by a very small spot of white (sometimes yellowish white) on the middle of the crown, but apparently are not otherwise different from the males. There is, however, much variation in color and size, and especially in the size of the bill, but it is apparently individual and seasonal rather than sexual. The 7 males measure as follows: wing, 1.58–1.88, averaging 1.77; tail, 1.36–1.46, averaging 1.43; culmen, .52–.58, averaging .55. The 6 females measure; wing, 1.66–1.80, averaging 1.70; tail, 1.28–1.40, averaging 1.34; culmen, .52–.57, averaging .54.

97. **Euscarthmus ochropterus** *Allen.*—Chapada, 15 specimens. There is nothing to add to the description of this species already given (see this Bulletin, II, No. 3, June, 1889, pp. 143, 144).

98. **Euscarthmus pelzelni** *Scl.*—One specimen, Chapada, May 23, 1885.

99. **Euscarthmus striaticollis** (*Lafr.*).—Two specimens, Chapada, ♂ ad., Feb. 18; ♀ ad. (no date).

100. **Hapalocercus meloryphus** (*Wied*).—One specimen, Chapada, Aug. 25.

101. **Habrura pectoralis** (*Vieill.*).—Chapada, 10 specimens—May, 2; July, 2; August, 4; September, 2. These specimens have already been commented upon in a comparison between *H. pectoralis* and *H. superciliaris* (Wied). (See this Bulletin, II., No. 3, June, 1889, p. 146.)

102. **Culicivora stenura** (*Temm.*).—One specimen, Chapada, ♀ ad., April 13.

103. **Serpophaga albogrisea** *Scl. & Salv.*—Three specimens, taken as follows: Abrilongo, ♂ ad., Feb. 28; Chapada, ♂ ad., July 20; juv. in first plumage, Nov. 6. The young bird

is brown above, with each feather narrowly edged with whitish; below, throat and breast dark ashy brown, faintly cross-barred with darker brown; rest of lower parts whitish with a faint tinge of greenish buff; under wing-coverts greenish yellow; wings and tail dusky brown.

104. Leptopogon amaurocephalus *Cab.* — Chapada, 10 specimens, collected as follows: February, 2; May, 1; June, 2; August, 1; November, 4. There is apparently very little seasonal or sexual variation, the series being remarkably uniform as regards both size and coloration. In November specimens the cap is paler, and the wing-bars are pale yellowish instead of ochraceous, as in the birds in fresher plumage. One of the specimens has the cap but little darker than the back and the wing-bars yellowish, thus resembling closely the description of *L. tristis* of Sclater and Salvin from Bolivia.

Six males measure as follows: wing, 2.47–2.67, averaging 2.56; tail, 2.06–2.33, averaging 2.20; culmen, .47–.52, averaging .50. Three females measure as follows: wing, 2.40–2.45, averaging 2.42; tail, 2.07–2.09, averaging 2.08; culmen, .50–.52, averaging .50.

On comparison with Panama specimens of *L. pileatus* Cab., the differences prove to be almost inappreciable. The brown-headed group of this genus, embracing *L. amaurocephalus*, *L. pileatus* and *L. tristis*, apparently constitute a widely dispersed species, perhaps barely separable into two or three geographical subspecies, the Central American form standing as *L. a. pileatus*, and the Bolivian form, if really separable, as *L. a. tristis.*

105. Myiopatis semifusca *Scl.*—Chapada, 6 specimens—April, 2; May, 1; August, 1; September, 2. The abdomen varies in different specimens from silky grayish white, faintly tinged with greenish, to a deep tinge of pale sulphur yellow.

106. Ornithion cinerascens (*Wied*)=*O. obsoletum* auct. (See this Bulletin, II, No. 3, June, 1889, pp. 148, 149.)

This species is represented by 12 specimens, taken at Chapada, as follows: February, 1; March, 1; April, 1; May, 2; June, 3; July, 1; August, 2; September, 1.

These specimens vary much in both color and size, the males being much larger than the females, and the coloration varying greatly with season. The brightest colored specimen is a male taken Sept. 17; the palest is a female, taken July 6. In the former the head is ashy olivaceous brown, the back strong greenish olive, the rump distinctly browner; wing-bars rusty ochraceous; below, throat olivaceous gray; rest of lower parts strongly washed with yellowish olive; edge of wing pale ochraceous. In the July specimen the head is much darker, with a distinctly dusky cap, the back grayish brown faintly tinged with olive, the wing-bars grayish white faintly tinged with ochraceous basally; below, throat and breast dull gray with a slight olivaceous cast, rest of lower parts grayish white, lighter (nearly white) on the middle of the abdomen, and washed with pale yellowish olive on the flanks. Between these extremes is nearly every stage of intergradation, clearly due to various seasonal phases.

The following measurements of 12 specimens (3 males, 4 females, and 5 unmarked for sex) show the range of variation in size. Wing, 2.00–2.25, averaging 2.09; tail, 1.46–1.78, averaging 1.61; culmen, .25–.32, averaging .28. The females are apparently slightly smaller than the males.

As already noted (l. c.) the *Ornithion obsoletum* of modern writers is the *Hylophilus cinerascens* Wied, as shown by his types, still extant in this Museum.

107. Elænea pagana (*Licht.*).—Of the 112 specimens of the *E. pagana* group from Chapada, about 48 per cent. are referable to *E. pagana* proper, and 40 per cent. to *E. pagana albiceps*, while the remaining 12 per cent. are variously intermediate between the two forms. As this material has already been made the subject of a special paper (see this Bulletin, II, No. 3, Oct., 1889, pp. 183–208), further comment is here unnecessary. Every month in the year except June is represented by a considerable series of specimens, rendering it possible to trace the seasonal phases of coloration throughout the year.

108. Elænea pagana albiceps (*d'Orb. & Lafr.*).—See above under *E. pagana*.

109. **Elænea gaimardi** (*d'Orb.*).—Three specimens, taken respectively Feb. 19, June 10, 1885, and July 27, 1883. Apparently a rare species at Chapada.

110. **Elænea viridicata** (*Vieill.*) = *E. placens Scl.*—One specimen, April 2, 1883.

There seems to be no reason to question the pertinence of Vieillot's *Sylvia viridicata* to this species.

111. **Elænea affinis** *Burm.*—This species is represented by 8 specimens, taken as follows: February, 3; March, 1; May, 3; December, 1.

The February and March specimens, in fresh unworn plumage, are more olive on the back than the May specimens. The December specimen is in molt, about one-half of the plumage being worn and faded, with which is mixed the freshly acquired and more olive new plumage.

Besides this well-marked seasonal difference in coloration, there is a wide range of individual variation in size, and a most remarkable variation in the size and shape of the bill, to which latter attention has already been called. (See this Bulletin, II, No. 3, 1889, pp. 191 and 207, and figs. 9–12 and 9*a*–12*a*.)

The 8 specimens measure as follows: 3 *Males*: wing, 3.32–3.44, averaging 3.39; tail, 2.58–2.92, averaging 2.74; exposed culmen, .50–.60, averaging .54. 5 *Females*: wing, 3.12–3.30, averaging 3.23; tail, 2.60–2.85, averaging 2.69; exposed culmen, .40–.56, averaging .48. The females are thus much the larger.

112. **Legatus albicollis** (*Vieill.*).—One specimen, ♂, Oct. 20, 1882.

113. **Sublegatus griseocularis** *Scl. & Salv.*—Of the 9 specimens representing this species 1 was taken in January, 1 in February, 1 in March, 1 in May, and 5 in August. They present the usual amount of seasonal variation in color, and also vary greatly in size, the larger specimens closely approaching Venezuela specimens of *S. glaber* in length of wing, but the bill is always very much smaller.

The measurements of seven adult specimens range as follows: 5 *Males*, wing, 2.52–2.62, averaging 2.57; tail, 2.14–2.22, averaging 2.20; exposed culmen, .26–.37, averaging .31; 2 *Females*, wing, 2.57–2.66, averaging 2.61; tail, 2.16–2.22, averaging 2.19; exposed culmen, .32.

114. **Sublegatus virescens** *Allen.*—The type and only known specimen of this species was taken at Chapada May 8, 1885. There is nothing to add to the description already given (this Bulletin, II, No. 3, 1889, p. 149).

115. **Myiozetes cayennensis** (*Linn.*).—The three specimens representing this species I am unable to distinguish from true *M. cayennensis* from northern South America and Panama. Two were taken in January, the other in August.

It may be mentioned in this connection that the type of *M. rufipennis* Lawr., from Venezuela, referred to *M. cayennensis* by Mr. Sclater (Cat. Bds. Brit. Mus., XIV, p. 160), is referable to *M. erythropterus*, with which it agrees perfectly in coloration.

116. **Rhynchocyclus sulphurescens** (*Spix*).—Represented by 6 specimens, taken as follows: ♀ ad., April 10; ♂ ad., May 2; ♀, Nov. 1; ♀ juv., Nov.; ♂ ad., Dec. 2.

In several of the specimens the auriculars are distinctly blackish posteriorly, in some cases forming a well-defined spot, mentioned as a feature of *R. peruvianus* Tacz.

Note.—Mr. Lawrence's **R. flavo-olivaceus** (Ann. New York Lyc. N. H., VIII, 1863, p. 8), of which the type is before me, represents the northern form of *R. sulphurescens*, and apparently may easily stand as a subspecies, under the name *R. sulphurescens flavo-olivaceus* (Lawr.). It is erroneously referred by Mr. Sclater (Cat. Bds. Brit. Mus., XIV, 1888, p. 169) to *R. cinereiceps*.

On the other hand, Mr. Lawrence's **R. marginatus** (Proc. Acad. Nat. Sci. Phila., 1868, p. 429), of which the two types are before me, is apparently a very distinct species, its nearest ally being *R. cinereiceps* Scl. Mr. Sclater erroneously refers it (l. c.) to *R. sulphurescens*, to which it is not at all closely related.

117. **Pitangus derbianus bolivianus** (*Lafr.*).—One specimen, ♂, Abrilongo, Feb. 23.

118. **Sirystes sibilator** (*Vieill.*).—Nine specimens, collected as follows: 1 in February, 3 in March, 1 in May, 1 in July, 1 in August, 1 in September, and 1 in October.

119. **Myiodynastes solitarius** (*Vieill.*).—The 5 specimens were taken, 1 in September, 2 in October, and 2 in November.

120. **Megarhynchus pitangua** (*Linn.*).—This species is represented by 10 specimens, taken as follows: March, 1; July, 2; September, 3; October, 1; November, 3.

One of the November specimens is a young bird in first plumage. It differs from the adult in having a much smaller bill, in lacking the concealed orange patch on the crown, in having the dorsal plumage brown (lacking the olive tinge of the adults), with all of the feathers broadly edged with pale rufous; and in the lower parts being clear pale sulphur yellow instead of deep yellow.

121. **Hirundinea bellicosa** (*Vieill.*). — Four specimens: December, 1; January, 2; July, 1.

122. **Pyrocephalus rubineus** (*Bodd.*). — This species is represented by 74 specimens, nearly all taken May to September inclusive. April is represented by 7 specimens and October by 2. No specimens were taken between Oct. 7 and April 10, and only 2 prior to April 22. It would thus seem that the species is absent from the vicinity of Chapada from early in October till early in April.

This species appears to undergo a double molt annually—a complete molt, probably in November and December, and a partial molt (the clothing plumage only) in May and June. This partial molt begins in April, and some males continue in mixed livery till September, the males probably not acquiring fully adult plumage till the second, and possibly not till the third year. The five males taken in April are all in the garb of the female, with here and there red feathers coming in on the crown, throat and breast; the crissum and lower flanks are orange red.

Of the May series of 10 males, 6 have partly acquired full breeding plumage, the crown being still more or less patched with brown, and the throat, breast and flanks streaked with whitish and dark brown, the red, however, greatly prevailing. The others have merely here and there a red feather on the crown, throat and breast. Of the 7 June males, one (taken June 30) is very nearly in perfect breeding plumage, four others are in mixed plumage with the red prevailing, while the other two show only here and there red feathers.

Of the 8 July males, four are in full breeding dress, three are more or less mottled with remnants of the immature plumage, while the other has here and there a few red feathers. Of the 6 August males, five are in full breeding dress, and the sixth is in mixed plumage. Of the 8 September males six are in full breeding dress, one has the red feathers of the throat and breast streaked with blackish, and the other is in mixed plumage. The single October male is in full breeding plumage. It thus appears that even in July, August and September a small proportion of the males are in mixed dress, having only scattered patches of red, while another small proportion have the red crown still more or less mixed with brown, and many of the red feathers of the lower plumage edged with whitish and broadly centered with blackish. This serves to divide the males into three categories—adult males (comprising about two-thirds of all), males of the second year, and males of the preceding year.

The females also exhibit much variation. A few are nearly uniform below, presenting little or no buffy yellow, orange or red on the lower flanks and crissum; the greater number have these parts suffused with yellowish buff, while in a few others they are pale red or orange red. This variation may be due also to differences of age.

The measurements of 10 adult males (in full breeding dress) and 10 adult females range as follows: *Males:* wing, 2.96–3.07, averaging 3.02; tail, 2.10–2.20, averaging 2.15; culmen, .44–.50, averaging .47. *Females:* wing, 2.80–3.12, averaging 2.96; tail, 1.97-2.30, averaging 2.14; culmen, .41–.48, averaging .45.

Pyrocephalus rubineus mexicanus, from Mexico and the southern border of the United States, as is well known, is rather lighter in coloration, both above and below, and is commonly supposed to be rather smaller than the South American *P. rubineus.* This, however, proves to be erroneous, the South American bird being the larger. For purpose of comparison I append measurements of 10 adult males and 5 adult females, from Pinal County, Arizona, collected by Mr. W. E. D. Scott. 10 *Males:* wing, 3.12–3.24, averaging 3.16; tail, 2.14–2.32, averaging 2.22; culmen, .42–.48, averaging .45. 5 *Females:* wing, 3.08–3.10, averaging 3.09; tail, 2.18–2.26, averaging 2.21; culmen, .44–.46, averaging .45. This shows an average difference of .14 of an inch in the length of the wing in 10 adult males of each form, respectively from Arizona and Southern Brazil, the *latter being the smaller.* Six specimens from Ecuador and Colombia average slightly larger than the Chapada birds.

123. **Myiobius nævius** (*Bodd.*).—The 6 specimens representing this species were taken as follows: Abrilongo, February, 1; Chapada, 2 in July, 1 each in August, September and October. In all the concealed vertical crest is yellow; two are sexed as males, two as females, and the others are not marked for sex.

124. **Empidochanes fuscatus** (*Wied*).(=*E. fuscatus* et *E. fringillarius* auct.)—The series of 25 specimens of this species were taken as follows: in May, 6; in June, 1; in July, 2; in September, 9; in October, 3; in November, 2; in December, 2. It presents a considerable range of both individual and seasonal variation in color. The May specimens, being in fresh unworn plumage, are of a deeper brown above, with a slight tinge of yellowish below, which in one specimen (taken May 12) is quite strong. In the September-December specimens the upper parts are much duller (more olivaceous) brown, and the faint yellowish wash on the lower parts has given place to a silky grayish white. The bill varies from nearly uniform dusky horn color (in some specimens nearly black) with the lower mandible usually a little lighter than the upper, to a much lighter brown, with the lower mandible light horn color, the basal half paling to a much lighter shade.

A young bird in first plumage (♂, Dec., 1882) differs from adults in having the upper plumage of a lighter, more rusty brown, with broader rusty edgings to the coverts and quills.

The present series of 25 specimens, all from the same locality, is not only far from uniform as regards coloration, but varies widely in respect to measurements. The bill, as in Flycatchers generally, and especially in *Elænea*, *Ornithion*, *Empidonax*, and allied genera, is exceedingly variable in form (its variability in color has already been noted above). The two extremes might readily be referred to different genera, so far as the bill is concerned. In the one case the bill is short and very broad at the base, in the other it is very long, with the breadth at the base actually much less than in the short-billed phase. This wide difference, however, seems merely individual, since the other specimens show a complete intergradation between the extremes.

The following measurements show the large range of variation in size: 18 specimens: wing, 2.47–2.82, averaging 2.66; tail, 2.32–2.78, averaging 2.58; culmen, .48–.54, averaging .52. Very few of the specimens are marked as positively idendified for sex, but so far as the evidence goes there appears to be no sexual difference in size.

From the foregoing I am led to doubt the distinctness of *E. fringillarius* Pelzeln from *E. fuscatus* Wied, the types of which latter are before me. The *E. arenaceus* (Scl. & Salv.) from Venezuela is apparently quite distinct from *E. fuscatus*.

125. Empidonax bimaculatus (*d'Orb. & Lafr.*).

Muscicapa bimaculata D'ORB. & LAFR. Syn. Av. (Mag. de Zool. 1837), p. 48; D'ORB. Voy. Ois. p. 320.
Empidonax bimaculatus SCL. Ibis, 1887, 65; Cat. Bds. Brit. Mus. XIV, 1888, p. 224.
Empidochanes euleri CAB. Journ. f. Orn. 1868, p. 195.
Empidonax brunneus RIDGW. Hist. N. Am. Bds. II, 1874, p. 263; Ibis, 1888, p. 463.
Empidochanes argentina CAB. Journ. f. Orn. 1868, p. 196.

This species is represented by 17 specimens, taken as follows: in January, 2; in February, 2; in March, 1; in April, 1; in May, 4; in July, 1; in September, 1; in October, 4; in November, 1. It is thus in all probability a resident bird.

The series presents the usual wide range of variation, in part seasonal and in part individual, with in addition much variation due to age. In freshly-molted birds the whole dorsal plumage is rufescent olive brown, with the head slightly darker; the lower surface is grayish white strongly tinged with pale sulphur yellow, the breast strongly washed with olive; the wing-bars and the edging of the quills pale ochraceous. In worn plumage there is rather less olive, both above and below, and the wing-bars are paler. In young birds the whole dorsal surface is more rusty olive, with the head strong ochraceous brown; the coverts and quills are more broadly edged with ochraceous, and there is usually a distinct third wing-bar, formed by the rusty ochraceous tips of the least wing-coverts. Below the broad olive breast-band is somewhat brownish. This phase (represented by four specimens) appears to represent the *Empidochanes euleri* of Cabanis, while the more or less faded post-breeding specimens appear to represent his *Empidochanes argentinus*. My *Empidonax bolivianus* and *E. lawrencei* (=*Ochthœca flaviventris* Lawr.) belong to the same group, but appear clearly separable, so far as present material goes. (See this Bulletin, II, No. 3, pp. 86 and 150.)

The measurements of 11 adult specimens show the following range of variation: 6 *Males:* wing, 2.50–2.62, averaging 2.54; tail, 2.27–2.49, averaging 2.36; exposed culmen, .45–.50, averaging .49. 5 *Females:* wing, 2.36–2.52, averaging 2.45; tail, 2.20–2.43, averaging 2.29; exposed culmen, .44–.46, averaging .46. The females thus average considerably smaller then the males.

126. Myiarchus tyrannulus (*Müll.*) (*M. erythrocercus* Scl., and of many authors).—The 34 specimens representing this species indicate that it is a permanent resident at Chapada. They were collected as follows: in January, 1; February, 0; March, 2; April, 1; May, 5; June, 3; July, 8; August, 8; September, 3; October, 1; November, 0; December, 2.

The amount of rufous on the inner vane of the outer tail feather is very variable, ranging from none whatever to a border occupying from one-third to two-thirds of the width of the inner vane. Four specimens show none whatever, and there is much less than the usual amount on the inner vanes of all the other rectrices; two show only a trace of a faint tinge of rufous on the inner vane of the second feather, while all of the rectrices are without rufous on the apical third of the feather. In others there is only a faint trace of pale rufous along the edge of the basal third of the inner vane of the outer feather. In still others it is of the usual width but very pale, sometimes becoming wholly obsolete towards the tip. The rufous margin of the inner vane of the rectrices thus varies not only greatly in extent but also in the depth of the rufous tint. Apparently the variation is purely individual, as young birds in first plumage present the same diversity in this respect as the adults.

In young birds the yellow and the gray is paler than in adults; the head, lower back and upper tail-coverts are rusty brown, decidedly in contrast with the back, and the quills of the wings and tail are more broadly edged with rusty.

There is the usual seasonal variation in color, due to wear and fading. The bill is brownish black, becoming often deep black, however, in the breeding season; it also varies greatly in respect to size and form. There is considerable variation in general size, but this is in large part sexual, as shown by the following measurements: 10 *Males:* wing, 3.56–3.82, averaging 3.67; tail, 3.20–3.58, averaging 3.36; exposed culmen, .70–.76, averaging .73. 8 *Females:* wing, 3.50–3.68, averaging 3.59; tail, 3.15–3.40, averaging 3.28; exposed culmen, .68–.76, averaging .72. *General average*, wing, 3.63; tail, 3.32; culmen, .72.

The relationship of the widely dispersed South American *M. tyrannulus* to certain closely allied West Indian, Central American and Mexican forms has been the subject of much comment, and and of much diversity of opinion among authors. As the large series of *M. tyrannulus* from Chapada affords a favorable basis for a renewed examination of the points at issue, I offer a short *résumé* of the subject based on a much larger amount of material than has previously been brought together.[1]

True *Myiarchus tyrannulus*, it may be premised, is not known from Central America, while *M. mexicanus*, its closely related North American representative, is not known from south of the southern boundary of Mexico. Another form closely related to these, *Myiarchus oberi*, has an extensive range in the Lesser

[1] In this connection I wish to acknowledge my indebtedness to Mr. Robert Ridgway, Curator of Birds in the U. S. National Museum, for the use of the large series of *Myiarchi* from southern Mexico, Central America and the West Indies contained in the National Museum, including the types of Mr. Ridgway's *M. nuttingi* and *M. brachyurus*, and of Mr. Lawrence's *M. oberi*. I am also indebted to Mr. George B. Sennett for his series of nearly 100 specimens from Texas and eastern Mexico, while our own Museum contains a large number of specimens from Arizona, Mexico and Central America, giving a total of over 300 specimens of the section of the genus *Myiarchus* with rufous-edged rectrices. Our Museum series contains the types of Mr. Lawrence's *M. yucatanensis* and *M. cinerascens*.

Antilles. These form what may be termed the *M. tyrannulus* group. *M. mexicanus* is represented by two forms, as follows: (1) *M. mexicanus*, of southern and eastern Mexico, ranging north to southern Texas; and (2) *M. mexicanus magister*, of western Mexico, ranging north into Arizona.

Myiarchus oberi Lawr. (Ann. New York Acad. Sci., I, 1877, p. 48), from the Lesser Antilles, is larger and darker than *M. tyrannulus*, with the bill longer, narrower, deeper and blacker. A series of 15 specimens (5 males, 7 females, and 3 not marked for sex, from Dominica, Granada, St. Vincent, etc.) measure as follows, the males as usual proving a little larger than the females: wing, 3.44–4.08, averaging. 3.76; tail, 3.16–3.88, averaging 3.53; exposed culmen, .74–.90, averaging .83.

Myiarchus mexicanus (Kaup)[1] is larger than even *M. oberi*, and also differs from it in its paler colors and broader, flatter bill. It is consequently much larger than *M. tyrannulus*, and has a relatively larger bill. While there is but little difference in the general coloration, the rufous on the inner vanes of the rectrices is rather broader and much more uniform in development, especially on the outer retrix.

Myiarchus mexicanus magister (Ridgw.) is scarcely distinguishable in coloration from *M. mexicanus*, when specimens strictly comparable as to season are compared. There is, however, considerable average difference in size, so that the two forms are very fairly entitled to recognition, as shown by the following measurements, where Arizona specimens (*M. m. magister*) are compared with specimens from the Lower Rio Grande (*M. mexicanus*).

Lower Rio Grande Valley (Hidalgo, and Lomita Ranch, Texas; Coll. George B. Sennett), 12 males and 12 females: *Males:* wing, 3.90–4.22, averaging 4.04; tail, 3.50–3.85, averag-

[1] I accept Dr. Sclater's conclusions (P. Z. S., 1871, p. 84) respecting Kaup's troublesome name *Tyrannula mexicana* as against Mr. Salvin's later opinion (Biol. Centr.-Am. Aves, II, 1889, p. 91), since Mr. Salvin admits that in the specimens "compared with Kaup's type," "the tip of the inner web of the outer tail-feather is rufous," and thus not like "typical *M. cinerascens*," to which, nevertheless, he refers Kaup's *Tyrannula mexicana*. If there be still any reason for doubt in the matter it seems better, in the interest of stability of nomenclature, to consider the case as settled by Dr. Sclater's comparisons, especially since the name *M. mexicanus* Sclater, if not the *Tyrannula mexicana* of Kaup, is the well-established cognomen of the bird so well characterized by Baird in 1859 as *Myiarchus cooperi*.

What the *Tyrannula cooperi* of Kaup was may never be determined, the type having been lost. Fortunately this is not important, since *Tyrannula cooperi* Kaup (1851) is forstalled by *Tyrannula cooperi* Bon. (1850) = *Muscicapa cooperi* Nutt. (1832) = *Tyrannus borealis* Swain (1831).

ing 3.64; exposed culmen, .77–.85, averaging .80. *Females:* wing, 3.67–3.92, averaging 3.79; tail, 3.30–3.58, averaging 3.46; exposed culmen, .74–.84, averaging .78. *General average:* wing, 3.91; tail, 3.55; culmen, .79.

Arizona (Pinal County), 6 males and 5 females: *Males:* wing, 4.24–4.46, averaging 4.33; tail, 3.91–4.22, averaging 4.04; exposed culmen, .84–1.00, averaging .94. *Females:* wing, 4.02–4.16, averaging 4.10; tail, 3.65–3.95, averaging 3.76; exposed culmen, .82–.98, averaging .88. *General average:* wing, 4.22; tail, 3.90; culmen, .92.

For fully twenty years these two forms have been practically recognized by American ornithologists.[1] It was not, however, till 1884 that they were clearly defined, when they were formally separated by Mr. Ridgway and their respective habitats defined.[2] Series from southern Mexico commonly include both forms, and also intermediate examples, the latter perhaps being resident birds and the former migrants from the north.

Myiarchus yucatanensis Lawr. (Proc. Acad. Nat. Sci. Phila., 1871, p. 235) was formerly referred by various writers to *M. mexicanus*. Of late, however, it has been currently accorded the rank of a species.[3] Mr. Ridgway (l. c.) and Dr. Sclater (l. c.) consider it as nearly related to *M. stolidus* of Jamaica, while Mr. Salvin (l. c.) compares it with *M. lawrencei*, to which it certainly bears a very close resemblance. The two original specimens (No. 42,841, Am. Mus. Nat. Hist., marked "type" by Mr. Lawrence himself, and No. 39,213, U. S. Nat. Mus.) are both in very worn plumage, and were these the only specimens known I should not hesitate to refer them to *M. lawrencei*. I am, therefore, quite willing to accept Mr. Salvin's view that there is "very little difference between these Yucatan birds (*M. yucatanensis*) and the form of *M. lawrencei* found in eastern Mexico from Vera Cruz northwards." While the types bear a strong resemblance

[1] *Cf.* Coues, Proc. Acad. Nat. Sci. Phila., 1872, pp. 65–79; Baird, Brewer and Ridgway, Land Birds N. Am., II, 1874, p. 331; Coues, Bull. U. S. Geol. Surv., IV, 1878, p. 32; Ridgway, Proc. U. S. Nat. Mus., I, 1878, p. 139.

[2] Proc. Biol. Soc. Washington, II, p. 90. See also further, Ridgway, Man. N. Am. Birds, 1887, p. 333.

[3] *Cf.* Ridgway, Proc. Biol. Soc. Washington, II, 1884, p. 92; Man. N. Am. Birds, 1887, p. 334; Sclater, Cat. Birds Brit. Mus., XIV, 1888, p. 260: Salvin & Godman, Biol. Centr.-Am., Aves, II, 1889, 93.

in coloration to worn specimens of *M. tyrannulus*, in which the amount of rufous in the tail is below the normal, this is evidently not the species to which they bear the closest affinity.

Mr. Ridgway's *Myiarchus nuttingi* (Proc. U. S. Nat. Mus., V, 1882, p. 394) barely needs mention in the present connection, its affinities being with *M. cinerascens* rather than with the *M. mexicanus* group. It is peculiar in having generally the whole inner vane of the outer retrix rufous ; in some specimens there is, however, a narrow dusky line on the inner side of the shaft near the tip, which, in exceptional specimens, broadens considerably apically. Such examples are hard to distinguish from occasional specimens of *M. cinerascens* in which the dusky spot at the tip of the inner vane is narrow, or not abruptly widened near the tip of the feather, as sometimes happens even in Arizona specimens of *M. cinerascens*.[1] Such examples may also be compared with small specimens of *M. mexicanus* in which the rufous on the inner vane of the outer retrix closely approaches the shaft. *M. nuttingi* is doubtless well entitled to recognition as a subspecies of *cinerascens*, under the name *M. cinerascens nuttingi* (Ridgw.).

Mr. Ridgway's *M. brachyurus* (Man. N. Am. Birds, 1887, p. 334) appears to be not clearly separable from *M. nuttingi*. There is no appreciable difference in coloration, while the habitat of *M. nuttingi* (southern Mexico to western Costa Rica) includes that of *M. brachyurus* (Nicaragua). The supposed difference between the two birds is thus essentially one of proportions respecting the relative length of the wing and tail, and is probably based on individual variation.

127. **Myiarchus ferox** (*Gmel.*) (*Myiarchus tyrannulus* of many authors, not of Müll.).—The 25 specimens of this species represent every month in the year, except July, as follows : January, 2 ; February, 3 ; March, 2 ; April, May and June, 1 each ; July, 0 ; August, 4 ; September, 4 ; October, 3 ; November, 3 ; December, 1.

[1] Since the above was written three specimens of alleged *M. nuttingi* have been recorded from Arizona (Fisher, Auk, IX, Oct., 1892, 394). Through the kindness of Dr. A. K. Fisher I have had opportunity to compare them with a large series of Arizona and Mexican specimens. The subject has also come before the A. O. U. Committee on 'Classification and Nomenclature of North American Birds,' which, after due consideration, reached the conclusion that *M. nuttingi* is merely a smaller southern form of *M. cinerascens* (see Auk, X, Jan., 1893, p. —).

The single December specimen is a bird of the year in first plumage. Below it scarcely differs from the adults; above the whole plumage is darker, the head decidedly rusty brown, the rump rufous, and the quills of the wings and tail broadly edged with bright rufous, and all the wing-coverts are edged broadly with grayish rufous. A January specimen in molt still retains part of the first plumage, the unmolted portions agreeing with the December specimen above described, part of the wing and tail feathers being rusty edged, etc.

The January and February specimens are all in molt. In freshly-molted birds (taken March to May) the color above is darker, and the gray of the throat and breast, and the yellow of the abdomen, are much deeper and stronger than in the specimens taken toward the close of the breeding season, which have become much lighter (especially more ashy above) through fading.

The measurements of 20 specimens, 12 males and 8 females, range as follows: *Males:* wing, 3.22–3.68, averaging 3.44; tail, 3.04–3.40, averaging 3.26; exposed culmen, .66–.72, averaging .69. *Females:* wing, 3.28–3.42, averaging 3.36; tail, 2.92–3.40, averaging 3.21; exposed culmen, .65–.72, averaging .69.

Mr. Lawrence's **Myiarchus venezuelensis** (Proc. Acad. Nat. Sci. Phila., 1865, p. 38) is a bird in fresh plumage (the type is before me) with the outer vanes of the tail-feathers conspicuously edged with bright rufous. It is probably not separable from *M. ferox.* The same author's **Myiarchus panamensis** (Ann. New York Lyc. Nat. Hist., VII, 1860, p. 284) seems entitled to rank as a larger northern form of *M. ferox*, and may be recognized as *M. ferox panamensis.* It is represented by the type and four other specimens from Panama, labeled as this species by Mr. Lawrence. In color these specimens present no very appreciable differences from the Chapada series. They measure as follows: wing, 3.40–3.78, averaging 3.59; tail, 3.34–3.54, averaging 3 44; exposed culmen, .72–.82, averaging, .76.

128. Empidnomus varius (*Vieill.*).—This species is apparently a summer resident only at Chapada. The series of 15 specimens was taken as follows: September, 3; October, 3; November, 1; January, 2; February, 6.

Two young birds, taken Feb. 21 and 24, are still partly in first plumage, entirely lacking the yellow at the base of the crest feathers, while the cap is brown, with the feathers edged broadly with rufous, as are also the wing-quills and the lesser and primary coverts, the others being broadly edged with white. The dorsal plumage generally is also more or less edged with rufous.

129. **Tyrannus aurantio-atro-cristatus** *d'Orb. & Lafr.*—The 7 specimens representing this species were taken one each in August, September and November, 2 in December, and 2 in February. It is to be inferred from this that it is only a summer visitor and not common.

One of the December specimens (taken Dec. 1) is a young bird in first plumage, with the quills not fully grown. Below it differs little in color from the adults, but above the upper tail-coverts, the quills, and the lesser and primary wing-coverts are broadly edged with dark rufous. The cap is dark brown externally, with the feathers basally rusty whitish, the central ones with a faint tinge of yellow.

130. **Tyrannus albogularis** *Burm.*—Evidently a summer visitor to Chapada. The series of 21 specimens covers the period from August 21 to February 24. The August and September specimens are in fresh plumage; in the January and February specimens the plumage is much worn and faded. The yellow of the lower parts varies from pale sulphur yellow to orange yellow, according to season.

The series shows a wide range of variation in the size and shape of the bill and in the depth of the forking of the tail, of which latter Dr. Sclater's figure (P. Z. S., 1880, p. 29) gives a rather exaggerated impression. The depth of the fork is generally under .75 in., varying in the present series from about .60 to .90. In other words it is only a little greater than in *T. melancholicus*, which, however, is a larger bird, thus increasing the relative difference.

Following are the measurements of 16 specimens, 8 males and 8 females: *Males:* wing, 4.13–4.37, averaging 4.27; tail, 3.60–4.02, averaging 3.82; exposed culmen, .70–.78, averaging .73. *Females:* wing, 3.96–4.22, averaging 4.08; tail, 3.46–3.82, averaging 3.60; exposed culmen, .96–.74, averaging .72. General average, wing, 4.17; tail, 3.72; bill, .72.

131. **Tyrannus melancholicus** (*Vieill.*).—Of the 22 specimens representing this species 15 were taken in September, 1885, and three others during the last week in August of the same year; two others were taken in September, 1882; the remaining two, one Feb. 28, 1883, and the other March 20, 1885. The species would thus seem to be an irregular visitor to the vicinity of Chapada, 18 of the 22 specimens having been taken during the month of September and the last week of August in 1885.

The March specimen is a young bird, just completing the molt from the first plumage. The yellow of the lower parts is much paler than in adults; the tail feathers are narrowly edged externally, and the two middle pairs also internally, with rufous; a few only of the colored crest feathers have appeared, and the tips of the primaries are not incised. The remnants of the first clothing plumage above are brownish gray. The rest of the series is quite uniform in coloration, although the yellow below varies somewhat in intensity in different individuals, and the olive brown above is much more greenish in some than in others.

The following measurements indicate the range of variation in size: 10 *Males*: wing, 4.28–4.72, averaging 4.50; tail, 3.98–4.50, averaging 3.83; exposed culmen, .84–.92, averaging .87. 6 *Females*: wing, 3.98–4.50, averaging 4.25; tail, 3.33–3.70, averaging 3.47; exposed culmen, .81–.90, averaging .86. The 18 specimens average as follows: wing, 4.38; tail, 3.65; culmen, .86. The forking of the tail varies from .45–.75, averaging about .60.

Besides the Chapada series, I have before me about a dozen other specimens from Southern Brazil and Bolivia. They agree very closely in size and coloration with the Chapada birds, but differ quite appreciably from other specimens from northern South America, Central America, Mexico, and southern Texas. While the whole form a rather closely connected series, the two extremes are exceedingly unlike. The northern form—*T. couchi* Baird (*T. melancholicus couchi* of recent American writers)—is easily distinguished from the true *T. melancholicus* of southern South America by (1) its much larger size (wing and tail each

.40 of an inch longer), (2) shorter and stouter bill, (3) much less deeply forked tail, (4) very much paler coloration both above and below (tail above grayish brown instead of black; the back olive gray instead of olive brown; throat and upper breast white instead of deep gray; less olive across the breast and the yellow of abdomen many shades deeper). Series of *T. m. couchi* and *T. melancholicus* when compared appear widely different, and specimens of either can be recognized at sight without the slightest difficulty. In fact, so far as the coloration of the ventral surface is concerned, *T. m. couchi* presents a very close resemblance to *T. albogularis.* For comparison in respect to size I append measurements of 7 specimens from the Lower Rio Grande Valley in Texas (Lomita Ranch, near Brownsville, Coll. George B. Sennett), as follows: 4 *Males:* wing, 4.70–4.98, averaging 4.89; tail, 3.68–4.15, averaging 3.91; exposed culmen, .80–.85, averaging .82. 3 *Females:* wing, 4.50–4.92, averaging 4.72; tail, 3.74–3.84, averaging 3.78; exposed culmen, .80–.86, averaging .83. General average of the 7 specimens (Chapada averages of 18 specimens in parenthesis for comparison); wing, 4.81 (4.38); tail, 3.87 (3.65); bill, .82 (.86). Depth of forking of the tail, .25–.35, averaging about .25 (.60).

A series of 8 specimens from Yucatan, Guatemala, and Panama (mostly unmarked for sex) are considerably smaller than the Texas series, averaging as follows: wing, 4.48; tail, 3.70; bill, .77. They are thus intermediate in size, as they are also in other characters, between *T. melancholicus* and *T. m. couchi.* Specimens from Cayenne, Trinidad, Venezuela, Colombia, and Amazonia are still smaller, and in coloration (except perhaps the Venezuela and Colombia specimens) more nearly approach *T. melancholicus.* They form, with the Central American birds, a thoroughly connected series, but being on the whole quite unlike either of the extremes, may very well stand as *T. m. satrapa*, under which latter designation the form was at one time recognized by various authors.

132. **Milvulus tyrannus** (*Linn.*).—Represented by 13 specimens, taken as follows: August, 5; September, 5; October 2; December, 1. Probably only a summer visitor.

(*To be continued.*)

Article XVIII. — CHARACTERS OF PROTOCERAS (MARSH), THE NEW ARTIODACTYL FROM THE LOWER MIOCENE.

By Henry Fairfield Osborn and J. L. Wortman.

Among the many interesting discoveries made by the American Museum Expedition of 1892 were the feet and portions of six skulls of a species of Artiodactyl which appeared to present entirely new characters. The finest specimen has proved to be a perfect skull with complete dentition; associated with another skull are the complete fore and hind feet. In writing from the field-camp Dr. Wortman described the skull as four-horned, but in the Museum, while the specimen was being worked out of its sandy matrix, we found six, eight and finally no less than ten bony protuberances upon different portions of the cranium! The chief pairs are on the parietals and maxillaries; prominent laterally projecting plates are also developed upon the supraorbital ridges of the frontals, and the frontals develop a second conical pair close to the nasal suture above the lachrymals. Besides the great vertical plates, the maxillaries present two lateral protuberances just above the third premolar on either side. The shape of these processes dismisses at once the idea that they were horn cores and indicates that they bore simply a dermal covering. Other features of the skull while less striking and novel are no less unique; among these are the deep cleft between the maxillary plates, the abbreviated nasals, the small vacuity between the nasals and frontals, the prominent ridge extending forward from the anterior margin of the orbit, and the prominent rugose sagittal crest. The grotesque appearance is heightened by the large canines which lend to the lateral aspect of the skull a decided suggestion of resemblance to that of *Uintatherium*.

The edentulous premaxillaries and short-crowned selenodont molars have the true ruminant appearance, but the structure of the feet at first sight suggests the Tragulines. We find two large and two small toes in the fore foot, all of them entirely separate, while the hind foot is supported upon two elongated and closely conjoined digits which form an incipient cannon bone.

Fig. 1. Lateral view of the male skull slightly oblique in position, ⅖ natural size.

Before looking for relatives of this remarkable animal, a second skull was uncovered, and it at first appeared to represent an entirely distinct species. The parietals were unfortunately lost in this specimen, but the frontals are complete and display no traces of either of the protuberances. Further examination, however, indicated the bases of the maxillary plates and of feebly developed canines, which suggested the idea that this skull might represent the female type while the former skull represented the male type of the same species. At this point Marsh's description of *Protoceras celer* was carefully studied and finally the supposed female skull was taken to the Yale College Museum, and upon being placed side by side with the type of *Protoceras* it was at once evident that they belong to the same species.

This enables us to fully characterize the male and female skulls of *Protoceras celer* Marsh, and to define the family *Protoceratidæ*, which Marsh was unable to do from lack of sufficient material.

We may now (1) define the family, (2) give a new definition of the genus based upon the discovery of the sexual characters and differences between the male and female, and upon the characters of the feet, (3) define the species. (4) We will then expand Marsh's description of the female skull; (5) in comparison with the male skull; (6) the structure of the fore and hind feet together with the cranial characters throws some light upon (7) the affinities of *Protoceras*.

Order ARTIODACTYLA.

Family PROTOCERATIDÆ *Marsh.*[1]

Molars brachy-selenodont. Upper and lower canines in both sexes. No upper incisors. Lower canines and incisors forming a single series. Male skull with bony protuberances upon parietals and frontals and vertical plates upon frontals and maxillaries. No true horns. Females with small parietal protuberances (maxillary plates unknown). Orbits posterior in position, prominent, widely separated. Optic foramina not confluent. Lachrymal duct with single orifice within rim of orbit. No lachrymal vacuity. Lachrymals articulating with nasals. Nasals extremely abbreviated. Maxillaries with large, free, superior border, produced (in the males) into a broad thickened plate rising above vertex of skull.

Fore feet with trapezium, trapezoid and magnum developed and distinct. Four complete, separate and functional metapodials, carpo-metacarpal articulation 'inadaptive.' Lunar resting equally upon unciform and magnum. Hind feet with two functional metapodials, lateral toes (II and V) incomplete. All elements of the pes separate in the young; tendency to form a cannon bone (III and IV) in adult stage. Ectocuneiform and navicular tending to combine (not with each other) with cuboid.

Fibula reduced to a malleolar bone tending to coössify with tibia. Ulna well developed, tending to coössify distally with radius.

This family is at present only known to include the genus *Protoceras* from the upper part of the White River Beds (Lower Miocene) of North America.

Genus **Protoceras** *Marsh.*[2]

Dentition: I $\frac{0}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{3}{3}$. First upper and lower premolars simple, bifanged, in diastema midway between canine and second premolar. Third and second upper premolars with strong internal cingula. Fourth upper premolar with single external and internal crescents. Lower incisors and canines with narrow spatulate crowns. Posterior nares open between second molars. Tympanic bulla not inflated. A strong lateral maxillary ridge.

Species **Protoceras celer** *Marsh.*[3]

Male: parietal protuberances large, laterally compressed, close together.

Female: parietal protuberances small, conic, widely separated.

Type: a female skull in the Yale College Museum.

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[1] "A Horned Artiodactyle (*Protoceras celer*) from the Miocene," American Journal of Science, January, 1891, pp. 81, 82.

[2] Loc. cit.

[3] Loc. cit.

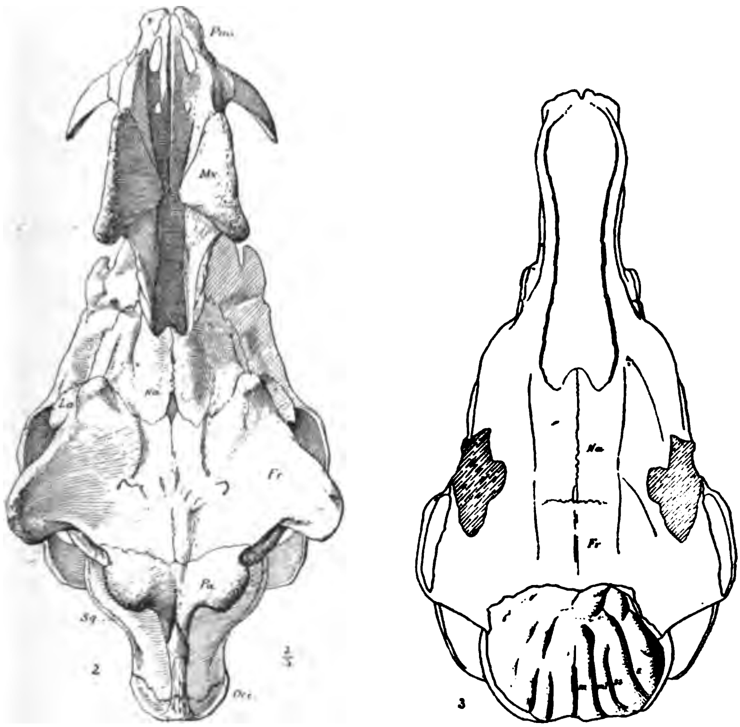
The Skull.

The Female Skull of Protoceras. History.—Marsh's type specimen is a skull with the posterior portion in fair preservation and the anterior portion broken off in a line just behind the anterior extremity of the nasals passing down just in front of the second premolar. In the following abstract of the author's description we omit some of the details, such as the absence of the first premolar, which are found to be incorrect:

"In general form and proportions this skull is of the ruminant type. Its most striking feature is a pair of small horn-cores situated, not on the frontals, but on the parietals immediately behind the frontal suture....The horn-cores are well separated from each other, and point upward, outward and backward, overhanging somewhat the temporal fossæ. They are conical in form with obtuse summits....The occiput is very narrow, indicating a small cerebellum, and the occipital crest is very weak. The occipital surface slopes backwards....The facial region of the skull is narrow and elongate. On the outer surface of the maxillary just above the antorbital foramen, there is a deep depression which probably contained a gland. The usual ruminant fossa in front of the orbit appears to be wanting. The orbit is large, and completely closed behind by a strong bar of bone....The paroccipital processes were well developed, but there were apparently no auditory bullæ....As the animal represented by this skull is very distinct from any hitherto described, the genus may be named *Protoceras* in allusion to the early appearance of horns in this group. The species may be named *Protoceras celer*. The characters now known suggest affinities with the giraffes, but indicate a distinct family which may be called the *Protoceratidæ*."

Measurements of Type.—Distance between orbits across frontals, 75 mm., about 3 inches. Distance between summits of horn-cores, 32 mm., about 1¼ inches. Width of palate between true molars, 32 mm., about 1¼ inches. Length of skull, estimated at 200 mm., about 8 inches.

The female skull in the American Museum collection is in fair preservation; it has the cerebral hemispheres exposed, and entirely lacks the parietals and the occipital ring; the nasals are complete to the tip; the maxillaries have lost the superior border; the premaxillaries are complete. It is thus impossible to determine whether the maxillaries bore the large vertical plates which constitute so striking a feature of the male skull. Three features indicate that these plates were absent; first, the upper broken border of the maxillaries is very thin; second, there are no protuberances or plates upon the frontals; third, the lateral ridge upon the maxillaries in front of the orbits is comparatively feeble and lacks the anterior projection. The wide contrast between the male and female skull is exhibited in the accompanying figures of the dorsal surface, and may be briefly summarized. The male skull is ornamented or armed with ten protuberances; the female skull bears but two small, low protuberances upon the parietals, not larger than the anterior pair upon the frontals of the male.



MALE. FEMALE.

Figs. 2 and 3. Top views of the male and female skulls, $\frac{2}{3}$ natural size.

The *brain* is deeply convoluted. We observe upon each hemisphere four longitudinal gyri, these according to Owen's nomenclature would be the median (*m.*), medilateral (*m*[l].), supersylvian (*ss.*), and sylvian (*s.*). This skull measured when complete about

225 mm. Below are the principal measurements of the male skull, which belonged to a younger individual, and is slightly inferior in size, measuring 215 mm.

Measurements of Male Skull.

	MM.
From occipital condyles to tips of premaxillaries	215
Greatest width, outside supraorbital plates	111
Length of face, from anterior margin of orbit forwards	130
Length of cranium from anterior margin of orbit to occipital crest	100
Greatest depth of maxillary plates	115
Outside measurement, upper molars	57
Length pm^2–m^3 inclusive	65

The Male Skull, Figs. 1, 2, 3.—The complete skull belongs to an animal about the size of a sheep, and is in an almost perfect state of preservation; all the sutures can be made out with certainty as outlined in the figures. The collection also contains portions of two other male skulls, one complete except in the posterior part and somewhat crushed; another, consisting of the complete posterior region and molar teeth; a third consisting of the anterior portion of the skull with the lower jaw as far back as the first premolar; with this individual the fore and hind feet were found associated. There are also two other fragmentary skulls not yet removed from the matrix.

Aside from the protuberances, the skull is long and low. Compared with the cervine type it is remarkable in the relative non-expansion of the olfactory chamber; there is in fact no space for great extension of the turbinals. Upon the upper junction of the frontals and nasals is an apparent foramen (this is less open in the more mature female skull).

A second distinctive feature is the exceptional development, correlated with the protuberances, of prominent ridges of bone which form a strong outer framework, thus the temporal fossa is bounded by rugose lambdoidal and sagittal crests, and by a strong buttress extending from the parietal horns to the postorbital bar and supraorbital plate. In front of the orbits the lachrymals are depressed between two ridges, the upper ridge extending into the frontal protuberance, the lower ridge consisting first of the malar (*ma.*) and then passing into the maxillaries, and terminating in a stout incurved hook above the infraorbital foramen. From this hook extends forward and upward a stout flange to brace the high maxillary plates. Immediately above this hook is the pit mentioned by Marsh; it probably did not contain a gland. Again, the vertical maxillary plates have a strong inward convexity, but are not quite in contact.

The protuberances are of two kinds; there are, *first*, the subconical projections, such as the elevated parietal processes crowning the superciliary ridges, which diverge, <-like, from the sagittal crest to the orbits; these parietal processes are flattened oval, and obliquely placed. Of somewhat the same character are the small semiprocumbent processes at the anterior margins of the frontals just above the lachrymals. The smallest of these processes are the hooks upon the lateral maxillary ridges, which none the less illustrate the extraordinary tendency of this little skull to rival the Dinocerata in developing a protuberance at every available point.

There are, *second*, the bony plates, which are flattened, with rugose margins. The supraorbital plates are developed upon the frontals and completely overhang the orbits, as shown in Fig. 2. Somewhat similar plates are seen in other Ungulates. The whole conformation of the maxillaries is, so far as we know, unique among the mammalia; the superior borders curve sharply upward into two powerful plates of bone, concave on the outer side and convex on the inner, and rising to the level of the parietal processes, with a concave posterior and convex anterior border.

Fig. 4. Anterior view of the male skull, ⅔ nat. size.

Cranial and Facial Bones.—The limits of the various elements of the skull can be clearly made out. The occiput is narrow and overhanging, the occipitals extend into the temporal fossæ; the paroccipitals are overlapped by the rugose periotics, beneath which the slender paroccipital processes emerge. The external auditory meatus is narrow and incompletely surrounded by the small tympanic elements. The squamosals have a small ascending plate ; as observed by Marsh, the postglenoid processes are small; the zygoma is rather slender. The malars are large, forming a horizontal infraorbital plate and extending forwards upon the face. The lachrymals are depressed but extend into a narrow surface of contact with the nasals; the foramina are internal. The parietals embrace the bases of the two posterior protuberances. The frontals bear the supraorbital plates and median protuberances; their upper surface has a strong median convexity bounded laterally by grooves for the supraorbital arteries and frontal nerves. This convexity continues into the nasals and terminates at their tips; in the female it forms the vertex of the skull, but in the male it lies in the centre of a hollow basin. The nasals are somewhat overlapped anteriorly by the maxillaries. The base of the skull displays a long narrow palate, narrowing opposite the diastema and broadening out into the smooth, perforated premaxillaries. The posterior nares open between the second molars.

The Foramina.—The infraorbital foramen is placed directly above the third premolar. The lachrymal foramen is within the orbit. There is a postglenoid foramen. The foramina lac-medius and lac-posterius are small. The foramen ovale is distinct.

The Dentition.—In the male the superior canines are trihedral and project outwards and backwards; the outer and inner faces are very slightly convex; the posterior face is flat and slightly worn. At a short interval are the first premolars, simple, laterally compressed crowns supported upon two fangs. The second premolars are behind a slightly greater interval. The outer surface is divided into a central cusp and two basal cusps, flanked by anterior and posterior styles; there is a sharply defined internal cingulum. The second premolar repeats the same characters, being more sharply defined. The fourth premolar has a shorter external crest, and the internal cresent is strongly developed, replacing the internal cingulum of the second and third premolars.

The true molars present a strong internal basal cingulum which envelops the inner surface of the crown; the outer surface of the crown is marked by prominent basal cusps, viz.: the parastyle, mesostyle and metastyle; the main external cusps are sub-crescentic, and present a strong median external ridge, their outer surface therefore is convex rather than flattened; the internal cusps, protocone and hypocone, are sharply crescentic. The molar dentition is therefore of an early type and decidedly brachyodont.

The inferior incisors present delicate spatulate crowns; the median second incisors are slightly larger than the lateral incisor, which is very delicate. The canine has precisely the same delicate structure as the lateral incisor. In the female the canines are apparently very much smaller, not exceeding half the diameter exhibited in the male.

In the fragment of the lower jaw the first lower premolar is seen to be separated widely from the canine.

The Fore and Hind Feet.

The materials upon which this description is based consists of an almost complete manus, including the distal ends of ulna and radius, together with both hind feet, to which the distal ends of the tibia and fibula are attached. Associated with these feet was found the anterior portion of the cranium bearing the lower jaw, so that their reference to *Protoceras* is undoubted. These are all that remained of what was once a complete skeleton deposited in position, but which had been almost completely destroyed by weathering away of the matrix. They pertain to a comparatively young animal in which the epiphyses had not yet fully united.

A second specimen is represented in the collection, consisting of the greater portions of both hind feet. This also pertains to a moderately young animal, but the epiphysis appear to be well joined to the rest of the bone and it can perhaps with safety be said to be fully adult.

In a general survey of the proportions of the limbs the same striking disparity in length and size is to be observed as is found in the Tragulidæ. The pes is much longer and stronger than the manus and, as in the Tragulines, had become much more highly specialized in the matter of reduction of the lateral digits. The pelvis, scapula and long bones are unknown.

The Fore-arm.—The ulna and radius, as indicated by their distal ends, display nearly the same proportions as are to be found in the existing Tragulines. The ulna is perhaps a trifle larger and stronger in proportion to the radius, with a greater expansion of its distal end. It is much better developed than in any of the existing Cervidæ. These two bones, although pertaining to a young animal in which the epiphyses are clearly indicated, are closely applied to one another, and display what may be regarded as a tendency to coössification. In old individuals it is highly probable that they will be found to be more or less completely joined by bony union.

The shaft of the radius, or what remains of its distal portion, is slightly crushed laterally so that its section cannot be made out, but there can be little doubt that it had the usual pattern displayed by the Tragulines and modern Deer. Upon the front of the bone, just above the articular extremity, there is a wide tendinal sulcus somewhat more marked than in either *Tragulus*, *Leptomeryx* or *Cariacus*. (In these latter genera there is an additional tendinal groove situated well over towards the ulnar side of the bone, which is apparently absent in *Protoceras*. Its absence in this specimen, however, may be due to age.) The distal extremity of the bone is marked by two facets for articulation with the scaphoid and lunar. That for the scaphoid is strongly convex from before backwards and is terminated in front by a shallow pit or depression which receives the anterior convex head of the scaphoid.

The process of bone which bears this facet is not produced backwards as it is in *Tragulus*, nor has it the marked obliquity seen in *Leptomeryx* and *Cariacus*, and to a less degree in *Tragulus*. The scaphoid facet is not sharply defined by a prominent ridge from that of the lunar as it is in *Cariacus*, *Leptomeryx* and *Tragulus*, the two articular surfaces being quite continuous in front.

The lunar facet is somewhat wider than that for the scaphoid, and like the latter is strongly convex from before backwards. It has little or no obliquity. It differs markedly from that of *Lep-*

tomeryx, in which it consists of a shallow cup-like depression with little posterior convexity associated with great obliquity. In *Protoceras*, as in *Tragulus*, the scaphoid surface occupies a lower level than that for the lunar, while in *Leptomeryx* the two facets are almost upon the same level.

In the complete absence of any articular facet for the cuneiform, the distal end of the radius differs from all modern Pecora and from the existing Tragulines, and agrees with *Leptomeryx*, an older Traguline.

The ulna is much compressed and applied closely to the radius at its lower fourth. Its distal extremity is occupied by an antero-posteriorly convex facet which articulates with the cuneiform. Except in its slightly increased size, in proportion to the radius, it does not differ from the corresponding bone in *Tragulus*.

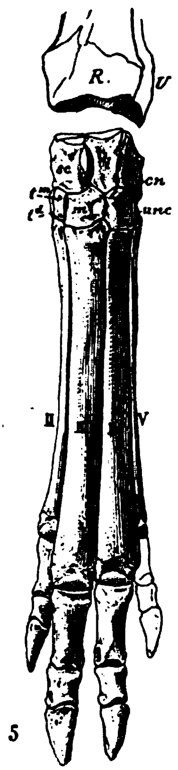


Fig. 5. Front view of manus, ⅓ nat. size.

The Carpus.—The carpus, while it resembles that of the Tragulines in a general way, nevertheless presents many features in details of structure which are different enough. One character in particular in which it appears to differ from both the Tragulines and the modern Cervidæ is the degree of elevation observable in the distal row of carpal bones. In *Cariacus* the vertical flattening of these bones is very marked, and it is also to be observed in the Tragulines, including *Leptomeryx*, although to a less degree. In *Protoceras* the elevation is considerably greater, so that the height of the two rows of bones is more nearly equal. In this respect it approaches *Oreodon* and the more generalized members of the Artiodactyla.

The scaphoid is one of the largest and strongest bones of the carpus. Proximally it presents a saddle-shaped articular facet where it joins the radius, in conformity with the usual pattern in the Artiodactyla. The anterior portion of this articular surface is occupied by a well-rounded transverse ridge extending entirely across the superior face and giving a width almost equal to that of the lunar. This ridge is received into the transverse depression upon the distal end of the radius. In *Tragulus* the proximal articular surface of this bone is much narrower than that of the lunar, and the anterior portion is thrown up into a prominent bony tubercle which is received into a corresponding pit or depression upon the articular face of the radius. Although the scaphoid is unknown in *Leptomeryx*, one would conclude from the depression in the radius at its point of articulation, that its structure is similar to that of *Tragulus*. In *Cariacus* the bone is similar to that of *Tragulus*, although the lateral narrowing is not relatively so great. Distally the scaphoid of *Protoceras* rests upon the magnum and trapezoid, being at the same time in contact with the rudimental trapezium.

The lunar is relatively high and narrow, being slightly wedge-shaped. Proximally it presents the usual pattern of the Pecora and Tragulines, but distally its articular surface is divided almost equally between the unciform and magnum. In this respect it differs radically from *Leptomeryx* and all other Tragulines, in which it rests almost entirely upon the unciform, offering to the magnum only a lateral contact. This character is considered by Cope[1] and adopted by Scott[2] as especially characteristic of the Traguline group.

The cuneiform is proportionally stronger than in the *Cervidæ*, and the saddle-shaped proximal facet is not extended down upon the external surface to the same extent as in either the Tragulines or the modern Pecora. It does not articulate with the radius.

The unciform is the largest bone of the carpus and articulates proximally with the lunar and cuneiform. Posteriorly it develops a strong hook-like process of bone, which is absent or nearly so in *Cariacus* but present in *Tragulus*. Distally it articulates with with metacarpals III, IV and V.

The magnum of *Protoceras* differs from that of both the Tragulines and the Pecora in that it is entirely free, and exhibits no tendency to coössification with the trapezoid. It articulates

[1] On the Structure of the Feet of the Extinct Artiodactyla of North America. Proc. Amer. Assoc. for Advancement of Science, 1884.

[2] On the Osteology of Mesohippus and Leptomeryx. Jour. Morphology, 1891, Vol. V, No. 3.

proximally with scaphoid and lunar, distally with metacarpals II and III.

The trapezoid is comparatively large and well developed. It assists in the support of the scaphoid and in turn rests solely upon metacarpal II. Internal to this bone is a small bone which represents the reduced trapezium. It has a small articular facet where it touches the scaphoid, but distally there is apparently no facet for the support of metacarpal I. If this first digit or any representative of it were present it was reduced to the merest rudiment. In the presence of this small trapezium the carpus of *Protoceras* is of a more generalized type, differing from both the Tragulines and the Pecora. This bone is, however, occasionally seen in the modern Cervidæ.[1]

The Metacarpus.—The metacarpus consists of four digits, all of which are distinct and show no tendency to unite. As regards the existence of the first digit, as remarked above, if present, it consisted of a rudiment. The lateral digits II and V are remarkable for their unusual size as compared with the median ones III and IV. They are relatively as large as those of *Oreodon*, although much more elongated and slender, to conform to the general pattern of the foot. They are but little inferior to the median digits in length, in this respect resembling *Leptomeryx*. Metacarpal II is slightly larger and slightly exceeds metacarpal V in length. Its principal articulation is with the trapezoid, but it offers a small oblique facet to the magnum, and is overlapped behind by the rudimental trapezium.

As metacarpal II articulates with two principal elements of the carpus, so does metacarpal III. The head of the bone is largely occupied by an articular facet for the magnum, but on its ulnar side it sends out a considerable process which joins the unciform and at the same time overlaps the head of metacarpal IV. Metacarpals IV and V articulate proximally with the unciform only.

The distal ends of all the metacarpals are provided with keels, which are confined to the palmar surfaces. These keels are flanked upon either side by a well-developed sesamoid, well preserved in the specimen described.

[1] See Baur: 'Der Carpus der Paarhufer,' Morphol. Jahrb., IX, 500, 602.

Summary.—A summary of the principal characters of the fore-limb, or, at least, what we know of it, may be made as follows: (1) Distal ends of ulna and radius tend to coössify. (2) There is no radial facet for the cuneiform. (3) There is little or no obliquity of the scaphoid and lunar facets on the radius. (4) The lunar rests equally upon unciform and magnum. (5) Trapezoid and magnum are not coössified. (6) A trapezium is present though small. (7) The unciform has a well-developed hook posteriorly. (8) The lateral digits are large, almost equaling the median ones in size. (9) Metacarpal III does not articulate with trapezoid, and the manus is therefore of the 'inadaptive' type. (10) The distal keels of the metacarpals are confined to the palmar surface.

Fig. 6. Front view of pes, $\frac{2}{3}$ nat. size.

The Hind Limb.—All that remains of the tibia and fibula are the extreme distal ends. Of the tibia we note the deep grooves for articulation with the astragulus, very much as in the recent genus *Cariacus.* The fibula is as completely reduced as in the modern Deer, the distal end consisting of a nodule of bone wedged in between the tibia and calcaneum. While this nodule, or malleolar bone, is free in the single specimen in which it is preserved, it nevertheless exhibits some tendency to coössify with the tibia, and it would not be at all surprising to find it completely joined to the tibia in older specimens.

Of the tarsus, the calcaneum has a relatively shorter *tuber* than is found in the modern Deer, and the facet for the malleolar bone is much more flattened. The astragulus presents no points of especial interest; it resembles very closely the corresponding bone in *Cariacus.*

The cuboid is relatively high and narrow, in this respect, resembling the Tragulines rather than the Deer.

Although closely applied to the navicular and the ecto-cuneiform it is not coössified with them as is the case in the Tragulines and Pecora. In a young specimen of *Leptomeryx* in our collection the cuboid and navicular are fully united and all traces of the suture are obliterated, notwithstanding the fact that the epiphyses had not yet united with the shafts of the long bones. Now in our young specimen of *Protoceras* the cuboid and navicular are perfectly free, but in the adult specimen there is some bony union. The line of junction, however, is clearly indicated by a more or less open suture. What is here said of the cuboid and navicular also applies to the cuboid and ecto-cuneiform, so far at least as the union of the latter with the cuboid is concerned. There appears to be no tendency to bony union of the ecto-cuneiform with the navicular.

The comparatively large bone which furnishes the principal support for the navicular, is, upon good and sufficient authority, stated to be a compound of the ecto- and meso-cuneiform in all the Pecora and some of the Tragulina. A very similar bone is found in *Protoceras*, but there is apparently no trace of any suture separating the two elements. It is safe to assume therefore that this bone represents the coössified ecto- and meso-cuneiform. Almost immediately behind this is to be found the ento-cuneiform. It differs in no important particulars from that of the Tragulines, *Leptomeryx*, and the Pecora.

The metatarsus consists of four elements of which the two median bones, metatarsals III and IV, are well developed and functional. The two median ones, viz.: Metatarsals II and V, are rudimental, incomplete and splint-like. In the young specimen metatarsal II greatly exceeds metatarsal V in size, extending somewhere between a third and a half of the way down the shaft of the large metatarsal III, while metatarsal V is but a short splint. In the adult specimen metatarsal II is very much shorter and is reduced quite as much as metatarsal V is in the young specimen. This is perhaps to be explained upon the basis of individual variation.

Metatarsal II articulates proximally with both the ento- and the meso-cuneiform, being applied closely to the shaft of metatarsal III. Its distal portion is not preserved, if it were ever present, so that no statement can be made concerning it. This is likewise true of metatarsal V.

Metatarsals III and IV are large and strong. In the young specimen they are entirely free, but in the adult there is some tendency to bony union exhibited, just as is observed in the cuboid, navicular and ecto-cuneiform of the tarsus. The fact of the matter is, the pes of *Protoceras* furnishes us with the transition stage between the condition wherein the elements are free, upon the one hand, and that wherein they become fused on the other. It is highly probable, as our specimens tend to prove, that previous to, and up to the time that the animal was fully adult, the elements of the pes were entirely free, but as age advanced there was a tendency for certain of the bones to become coössified. We are of the opinion, however, that bony union had, at no time during the life of the individual, gone so far as to obliterate all traces of the connections between the originally separate elements. In this sense no cannon bone can be said to exist in *Protoceras*. The bony union at most was but incipient.

In metatarsals III and IV the distal keels are confined to the plantar surface and are therefore not complete as in the modern Ruminants. The phalanges do not offer any important points of difference from those of allied forms.

Systematic Position of Protoceras.

It now remains to discuss briefly the systematic position of this unique genus. Scott, following Rütimeyer,[1] gives the principal characters of the tragaline skull, including the American Miocene genus *Leptomeryx*, which, as he has shown, probably belongs here, as follows: "(1) Size very small. (2) Craniofacial axis straight. (3) The orbits very large, median in position, and separated by a thin septum, but not projecting much beyond the sides of skull; optic foramina confluent. (4) The cranium long, narrow and low, and the parietal zone correspondingly long. (5) Occipital surface unusually high, narrow and convex (flattened or concave in *Leptomeryx*), and supraoccipital extended upon the side walls of cranium. (6) The alæ orbitales

[1] On the Osteology of Mesohippus and Leptomeryx, pp. 358, 359.

extraordinarily extended, reaching roof of the skull. (7) A short sagittal crest formed. (8) Frontal zone limited to roof of the orbits and nasal cavity. (9) Auditory bullæ large and filled with cancellous tissue (small and not filled with cancellous tissue in *Leptomeryx*)." To these we may add: (10) no horns or bony protuberances upon the cranium, and (11) "the lachrymal orifice single and placed outside the orbit (McAllister)," "inside the orbit in *Leptomeryx* (Scott)."

If now we contrast the characters of the skull of *Protoceras* with those of the Tragulina just given, it will be seen that the differences are very great. (1) Omitting Scott's first character as of comparatively little value, since it is a matter of specific variation in other forms, they may be tabulated as follows: (2) In *Protoceras* the face is considerably bent down upon the craniofacial axis as in the Pecora. (3) The orbits are large, lateral in position, widely separated and project well beyond the side wall of the skull. The optic foramina are not confluent. (4) The cranium is long, flattened and of great breadth between the orbits; the parietal zone is relatively short. (5) The occipital surface is high and narrow and the occipitals overlap the lambdoidal crests so as to appear upon the side walls of the skull. (6) This character cannot be fully determined in our specimen. (7) A very prominent, although moderately short crest is formed in the male, less prominent in the female. (8) Frontal zone limited behind by parietal protuberances. (9) The auditory bullæ not inflated. (10) Strong bony protuberances on parietals, in males well developed, in females rudimental; in males there are in addition bony protuberances over the orbit and in front of the orbit on the frontals, besides the large maxillary plates in front. (11) The orifice of the lachrymal duct is single and situated inside the orbit.

From this it will be seen that in the general pattern of the skull *Protoceras* differs widely from that displayed by any member of the Tragulina. The more striking and important of these differences are to be seen in the position and wide separation of the orbits, the possession of parietal protuberances and the general conformation of the muzzle. It is true that in the character of the occiput it resembles the Tragulines, but it is not certain but that some of the more primitive members of the Pecora were possessed of a similar structure. In the matter of the tympanic bullæ and the position of the lachrymal orifice it agrees with *Leptomeryx*, but differs from the rest of the Tragulines. These latter characters are probably but parallelisms and have little bearing upon the general question of genetic affinity.

In the structure of the limbs we meet with more decided resemblances to the Tragulines, but in the absence of more complete knowledge of the limb structure of the earliest representatives of the Pecora we are not prepared to say whether these resemblances are not equally great to this latter group. The manus furnishes two striking characters in which *Protoceras* differs from all the Tragulina, viz.: the support for the lunar being furnished by the unciform and magnum equally and the manus being of the 'inadaptive type,' whereas in the Tragulina the principal support for the lunar is furnished by the unciform, and the manus is of the 'adaptive type.' The character of the lunar articulation is considered by Cope to be especially distinctive of the Tragulines, and it is undoubtedly true that it is very constant and serves to distinguish them sharply from the Pecora. The adaptive or inadaptive character of the manus is perhaps of less value in indicating relationship, since it appears, in some measure at least, to be influenced by the reduction of the digits. Such a condition is met with in the Oreodontidæ.

Other characters of the carpus, such as the separate condition of magnum and trapezoid, the presence of separate trapezium, and the very large size of the lateral metacarpals are features common to the more generalized types of the Artiodactyla, and serve to distinguish *Protoceras* sharply from both the Pecora and the Tragulina. The lack of obliquity of the facets at the distal end of the radius is also a character which belongs to the primitive members of the order and serves to distinguish it from both the Tragulines and the Pecora, while the absence of a cuneiform facet on the radius, as well as the presence of the distal keels of the metapodials on the palmar surface only are shared with certain members of the Tragulina, notably *Leptomeryx*.

If we associate *Leptomeryx* with the Tragulines, then the differences in the structure between the pes of the Pecora and the

Tragulina is comparatively slight. The pes of *Leptomeryx*, as was shown by Scott, is remarkably like that of the modern Ruminants in the reduction of the lateral digits and the coössification of the cuboid and navicular, and at the same time in having ecto-meso-cuneiform free. In *Protoceras* the condition is more primitive, in that the cuboid and navicular are not fully united, nor can the cannon bone be said to be fully formed. In these particulars it departs from both the Tragulina and Pecora and again approached the lower types.

If now we compare *Protoceras* with any family of the Pecora, there are so many striking differences at once apparent that we are compelled to conclude that there are no marked affinities in the direction of any of these families. In the possession of bony protuberances on the parietals, which are probably processes of this bone and not developed separately as in the Giraffe, in the general architecture of the skull, together with so many primitive characters of the feet, this genus apparently occupies a distinct position and cannot be consistently referred to either the Tragulina or the Pecora as at present constituted and defined. The possession of multiple horns suggests the possible relationship of this family to the Sivatheriidæ, but the likeness does not extend to other features of the skull.

That it represents a distinct family there can be little doubt. Of its successors we know nothing whatever, and our ignorance is equally great in the matter of its ancestry.

The following table exhibits, in condensed form, the principal characters of this family in contrast with those of the families of the Tragulina and the Pecora:

TRAGULINA. *Tragulidæ.*	PROTOCERATIDÆ.	PECORA. *Giraffidæ, Cervidæ, Bovidæ.*
(1) No horns, antlers or bony protuberances upon cranium.	(1) Paired bony protuberances on parietals, frontals and maxillaries in males.	(1) Horns, antlers or bony protuberances present.
(2) Orbits median in position, not projecting laterally; optic foramina confluent.	(2) Orbits lateral in position, projection well beyond side wall of skull; optic foramina not confluent.	(2) Orbits as in Protoceratidæ.
(3) Nasals normal and articulating with superior border of maxillaries in front. No flanges on maxillaries.	(3) Nasals much reduced and not articulating with superior border of maxillaries in front. Maxillaries in males produced into a pair of large bony plates rising above the vertex of the skull.	(3) Nasals normal (somewhat reduced in *Alces*) and articulating with superior border of maxillaries in front. No maxillary plates.
(4) Occiput high and narrow; occipitals overlapping lambdoidal crest; a sagittal crest formed.	(4) Occiput high and narrow; occipitals overlapping lambdoidal crest; a sagittal crest.	(4) Occiput low and broad; occipitals not overlapping lambdoidal crest. No sagittal crest.
(5) Distal end of radius with or without facet for articulation with cuneiform. Facets for scaphoid and lunar oblique.	(5) Distal end of radius without facet for articulation with cuneiform. Facets for scaphoid and lunar with little or no obliquity.	(5) Distal end of radius with facet for articulation with cuneiform. Facets for scaphoid and lunar very oblique.
(6) Carpus of the adaptive pattern.	(6) Carpus of the inadaptive pattern.	(6) Carpus of the adaptive pattern.
(7) Lunar resting almost exclusively upon the unciform, and having only a lateral contact with magnum.	(7) Lunar resting equally on magnum and unciform.	(7) Lunar resting equally upon magnum and unciform.

(8) Trapezoid and magnum coössified.	(8) Trapezoid and magnum separate.	(8) Trapezoid and magnum coössified.
(9) Trapezium absent or coössified with trapezo-magnum.	(9) Trapezium present and separate.	(9) Trapezium absent, rudimental or coössified with trapezo-magnum.
(10) Lateral digits of manus complete; cannon bone present or absent.	(10) Lateral digits of manus complete, large and well-developed; no cannon bone.	(10) Lateral digits incomplete and splint-like; a cannon bone always present.
(11) Distal keels of metacarpals incomplete and confined to palmar surface.	(11) Distal keels of metacarpals incomplete and confined to palmar surface.	(11) Distal keels of metacarpals complete (except in Giraffe).
(12) Cuboid, navicular and cuneiforms coössified (excepting in *Leptomeryx*, where ecto-meso-cuneiform is free) with obliteration of suture in adult.	(12) Cuboid tending to coössify separately with navicular and cuneiforms, persistent suture in adult.	(12) Cuboid and navicular coössified, with obliteration of suture in adult.
(13) Lateral digits of pes complete (except in *Leptomeryx*); cannon bone present or absent.	(13) Lateral digits incomplete, splint-like; median metatarsals, if coössified into a cannon bone, a persistent suture present.	(13) Lateral digits incomplete, splint-like; and median metatarsals always coössified into a cannon bone, with suture obliterated in adult.
(14) Distal keels of metapodials confined to plantar surface.	(14) Distal keels of metapodials confined to plantar surface.	(14) Distal keels of metapodials complete (except in Giraffe).
(15) Posterior limbs greatly exceeding anterior limbs in size and length.	(15) Posterior limbs greatly exceeding anterior limbs in size and length.	(15) No marked disparaity in length between fore and hind limbs.

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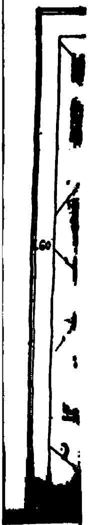

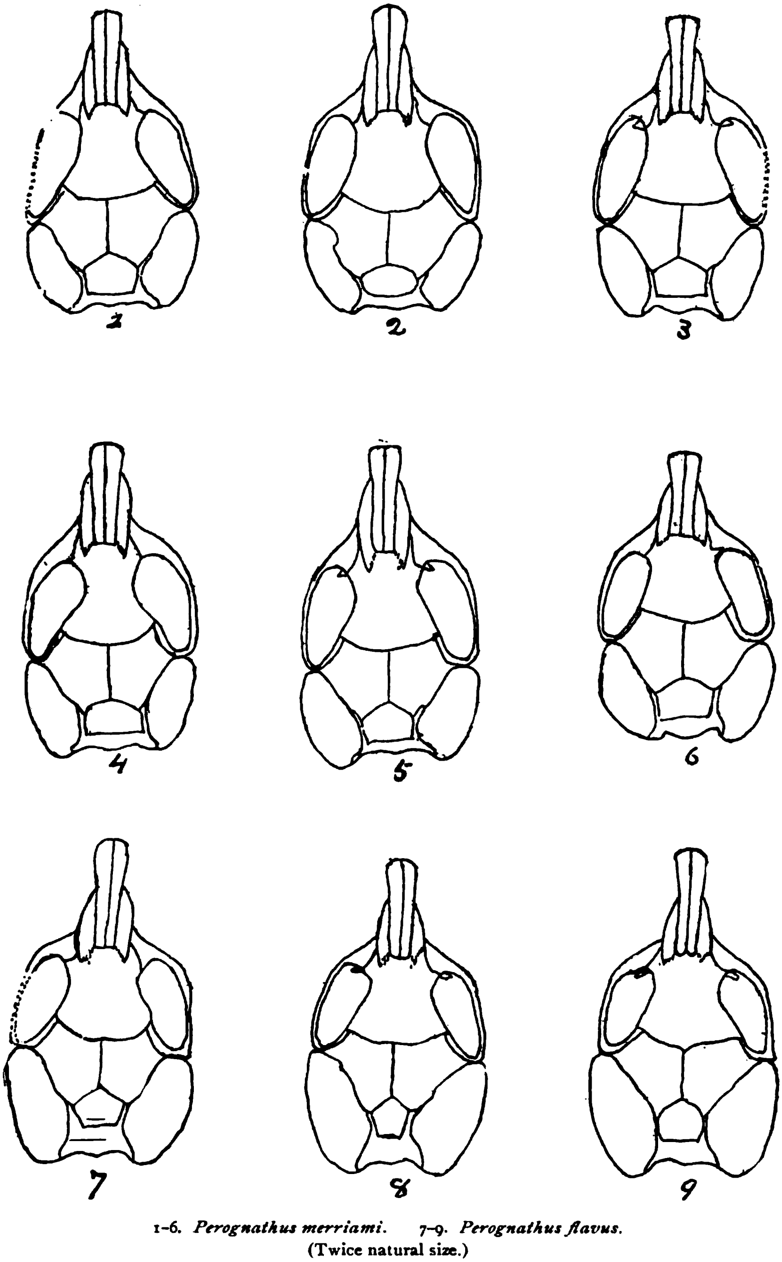

1–6. *Perognathus merriami.* 7–9. *Perognathus flavus.*
(Twice natural size.)


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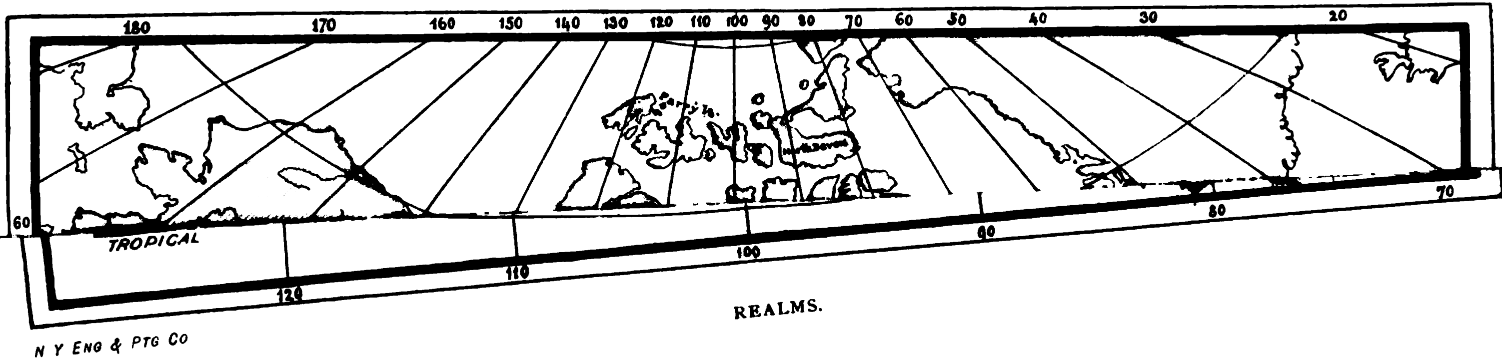
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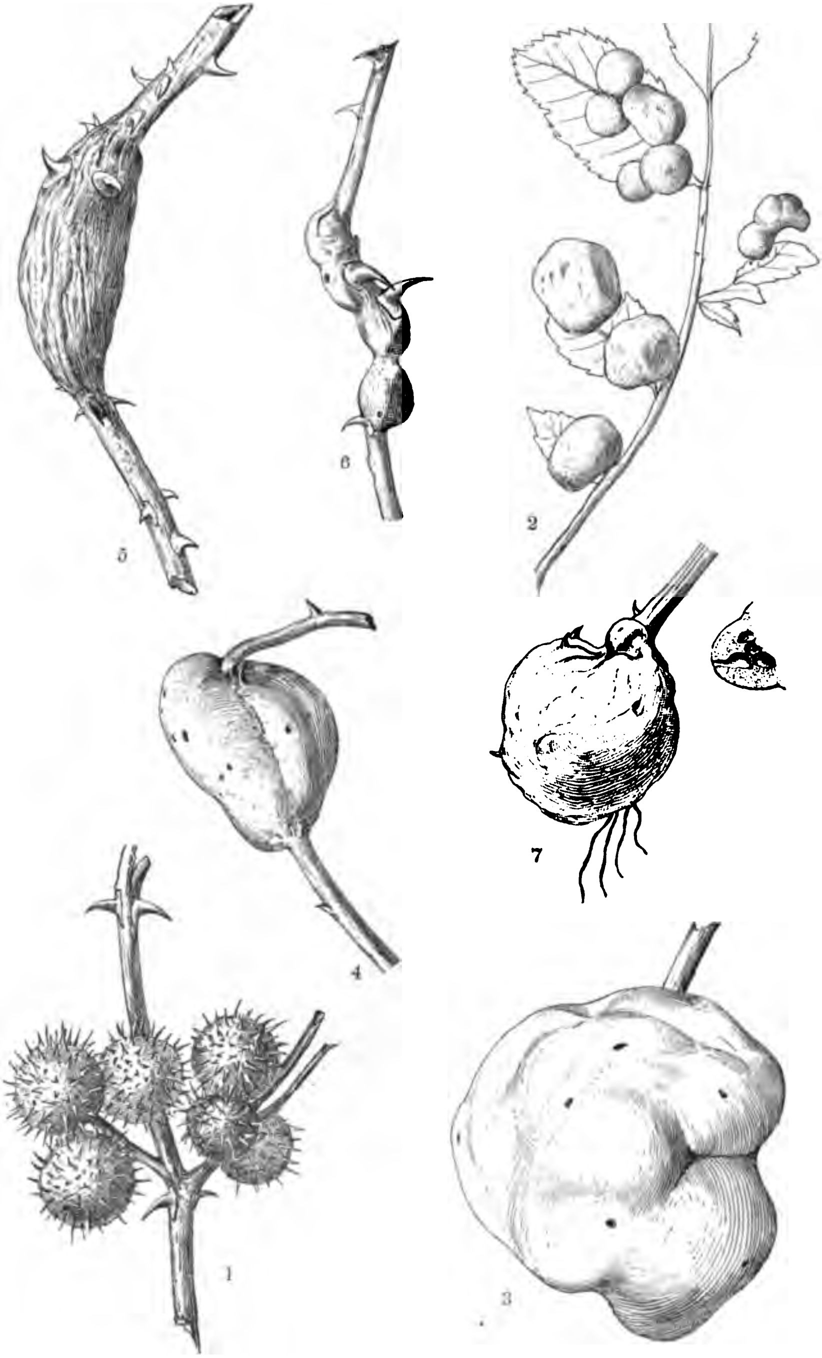
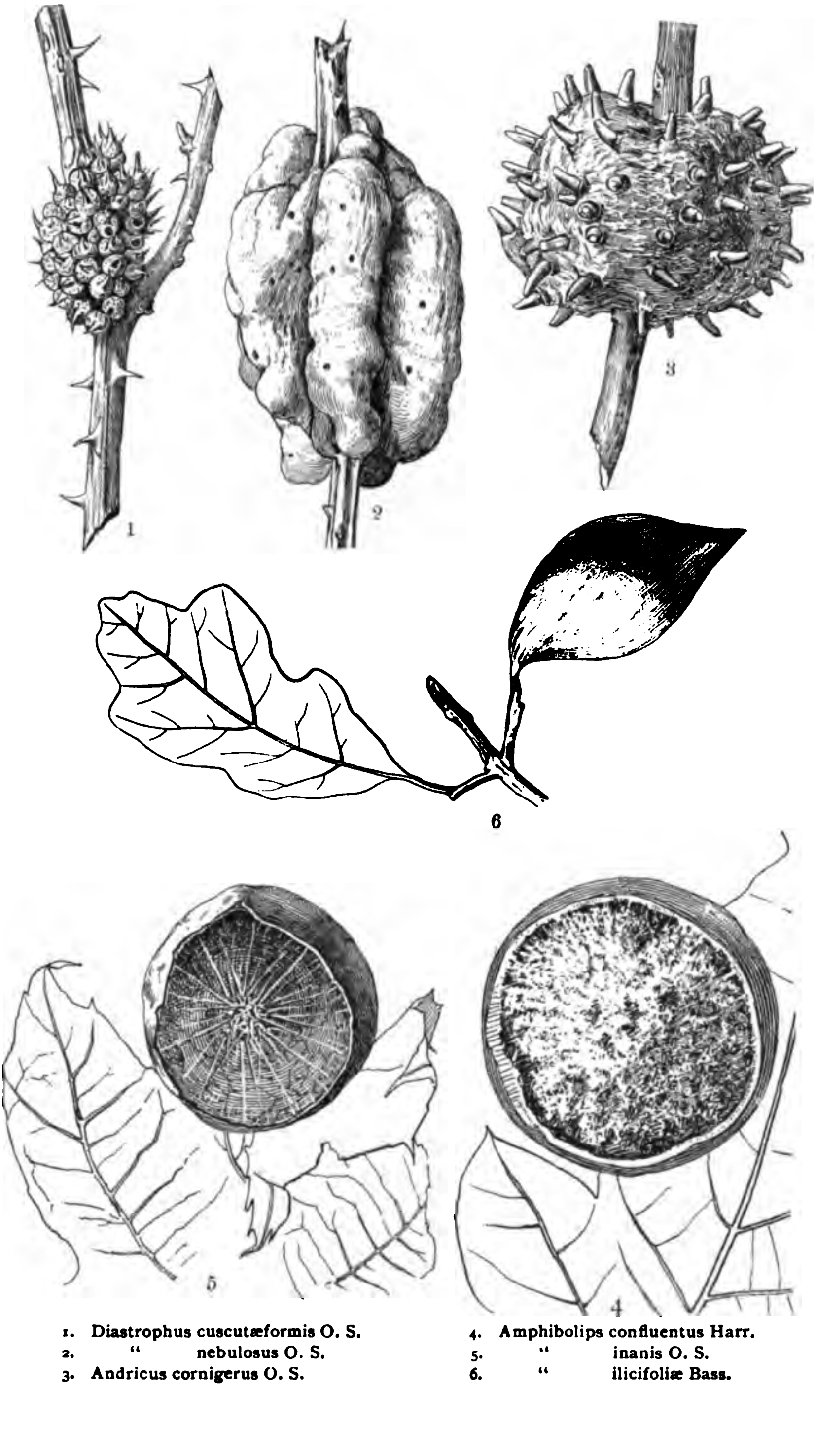
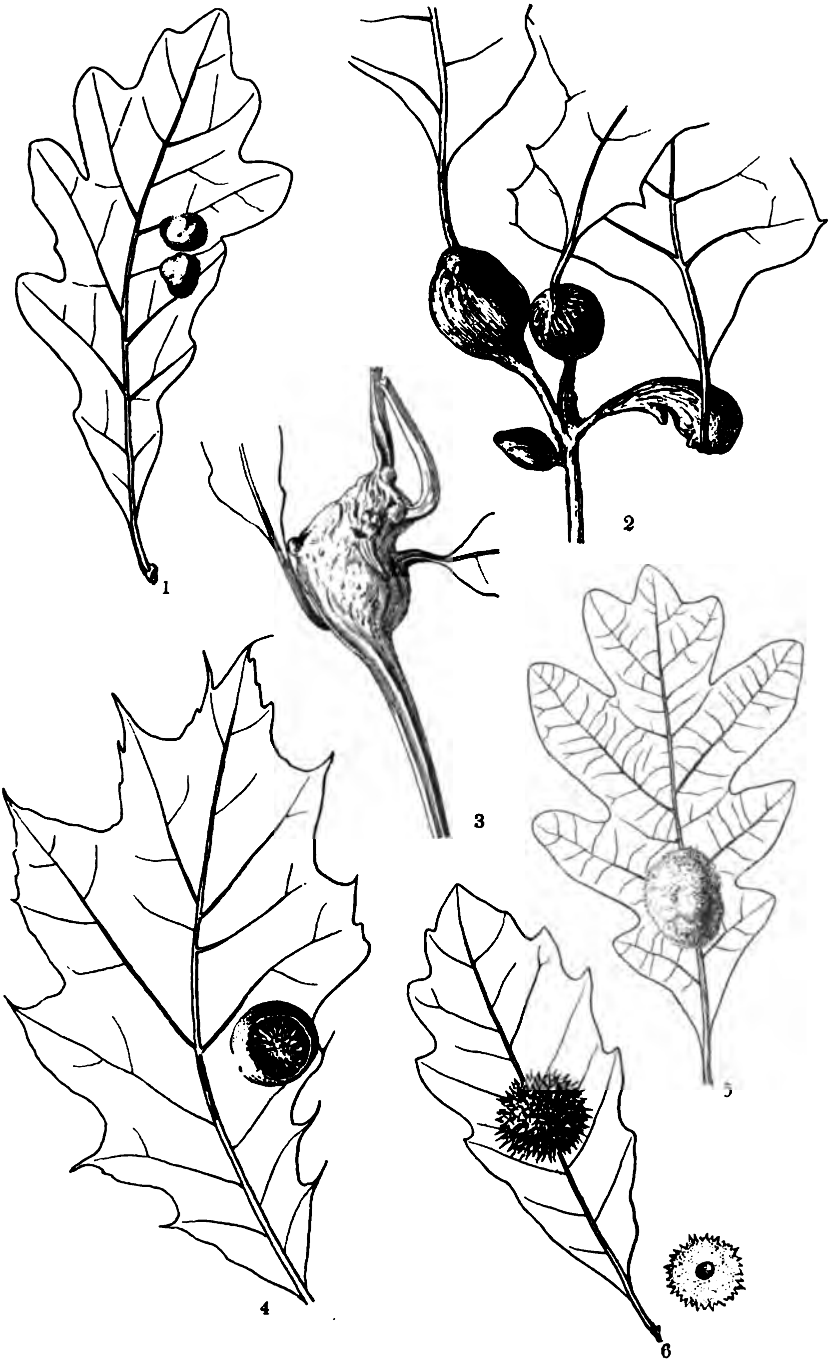


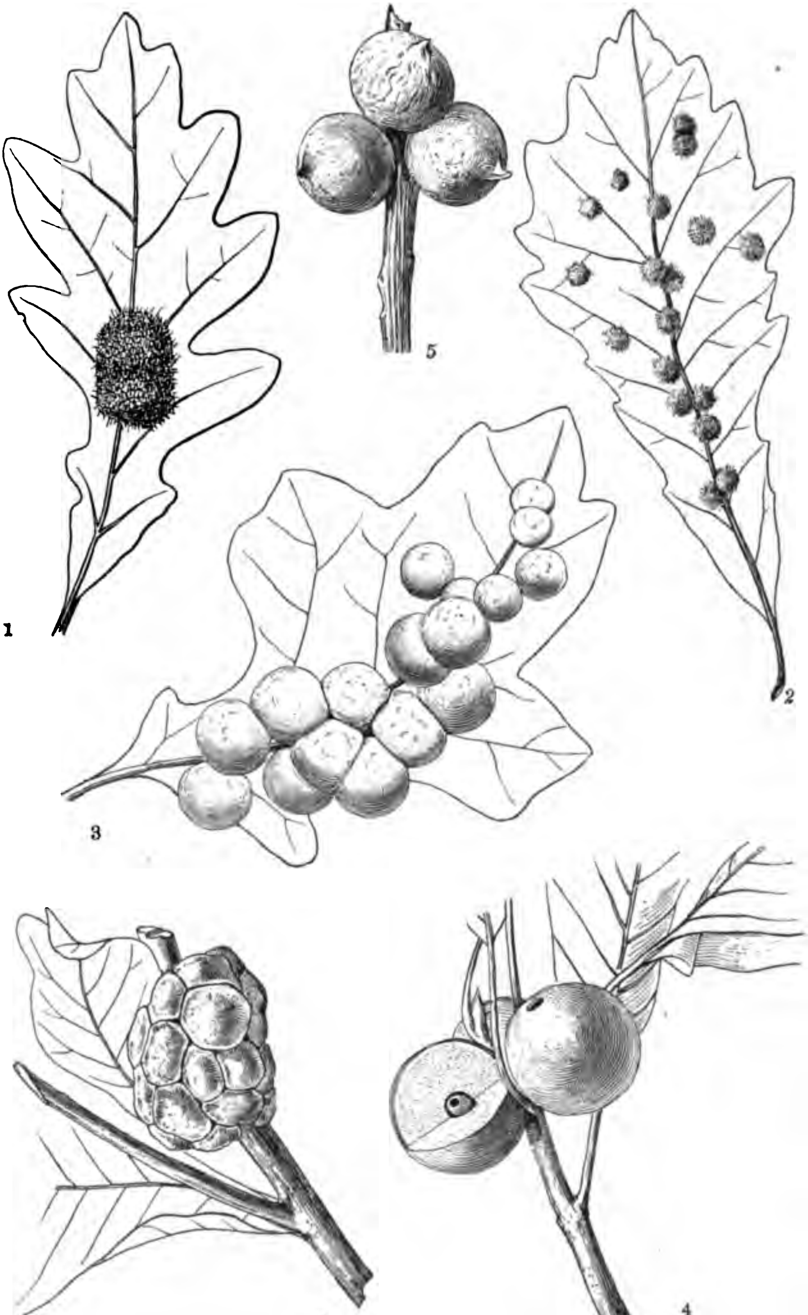
1. Rhodites bicolor Harr.
2. " ignota O. S.
3. " radicum O. S.
4. Rhodites globulus Beut.
5. " dichlocerus Harr.
6. " verna O. S.
7. Diastrophus bassettii Beut.



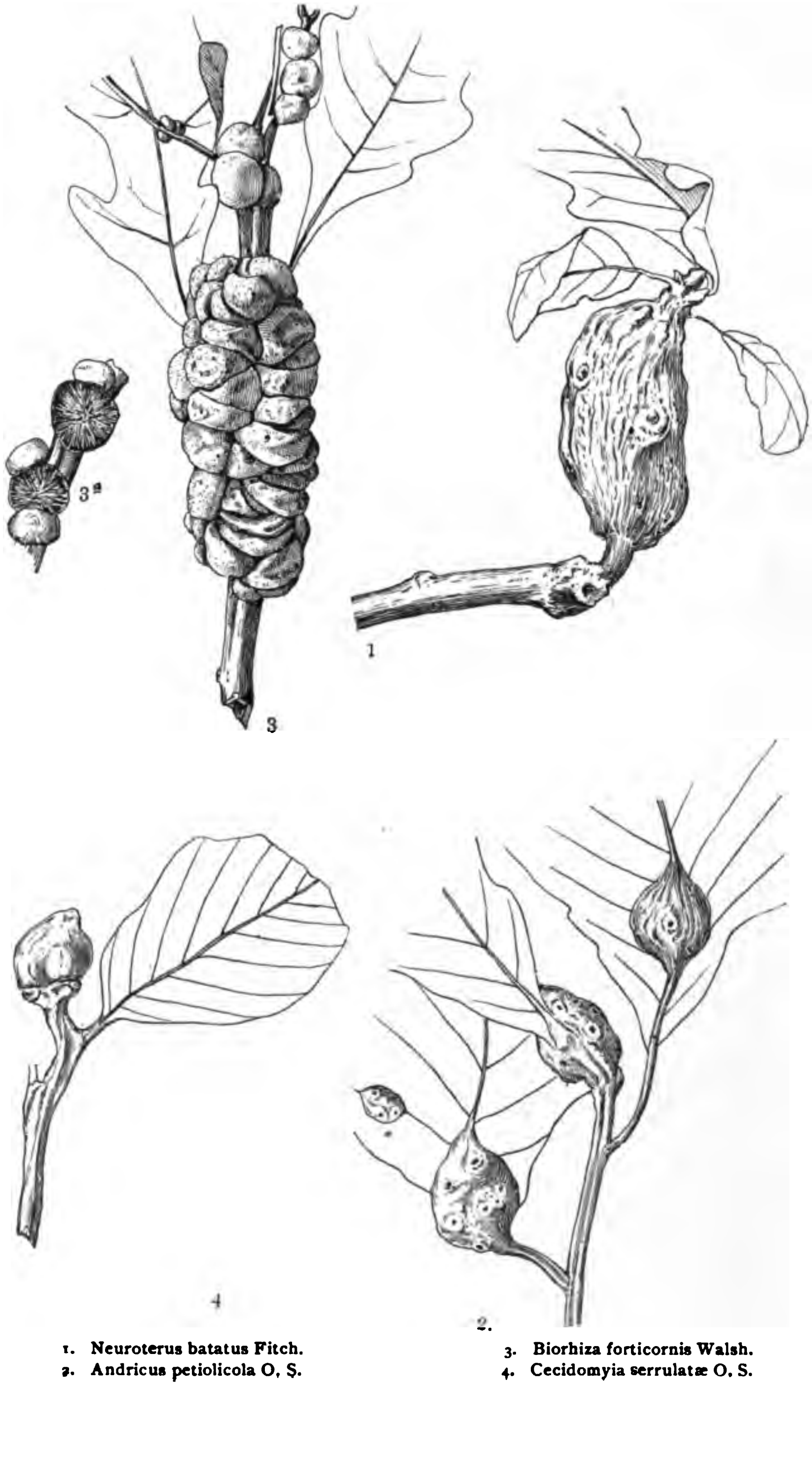
1. Diastrophus cuscutæformis O. S.
2. " nebulosus O. S.
3. Andricus cornigerus O. S.
4. Amphibolips confluentus Harr.
5. " inanis O. S.
6. " ilicifoliæ Bass.



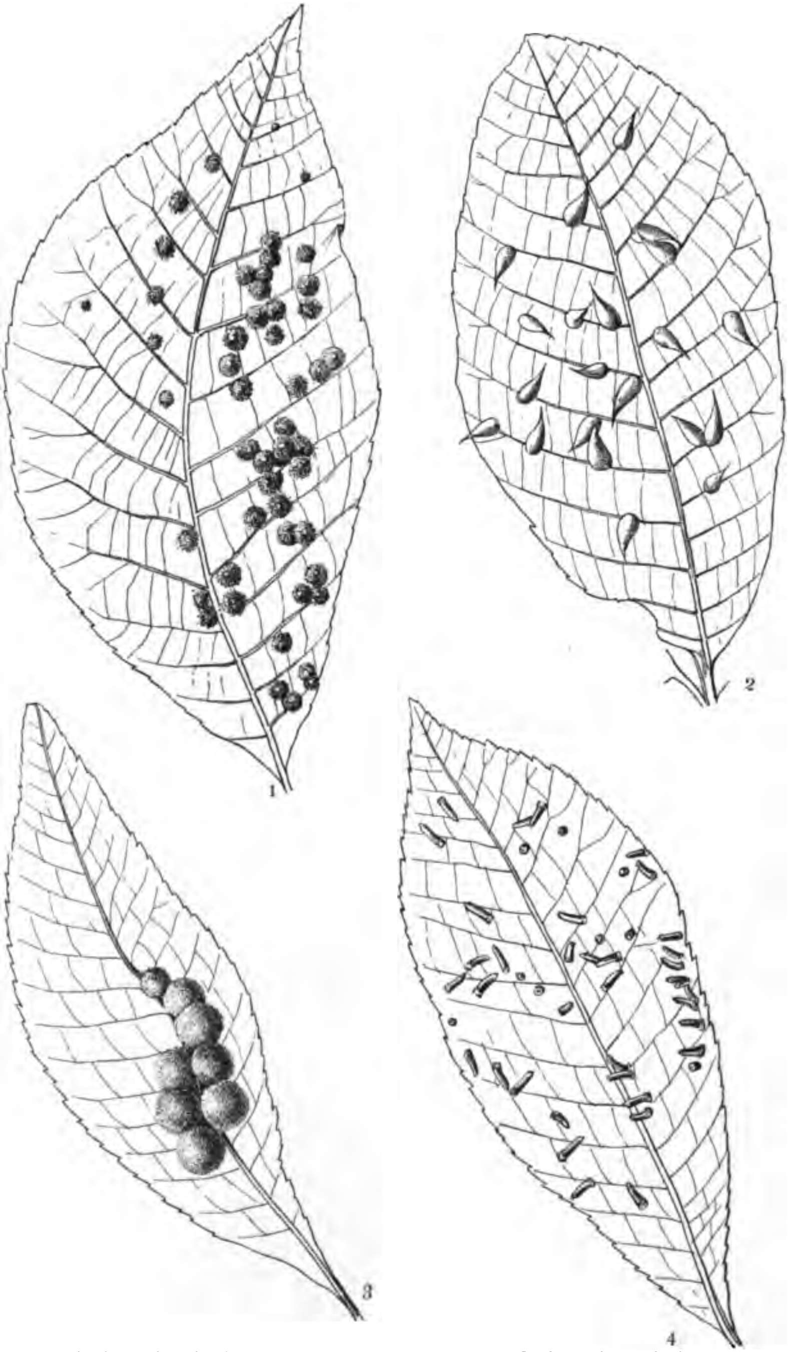
1. Andricus futilis O. S.
2. " similis Bass.
3. " clavula Bass.
4. Andricus singularis Bass.
5. " lana Fitch.
6. Cynips (?) prinoides Beut.



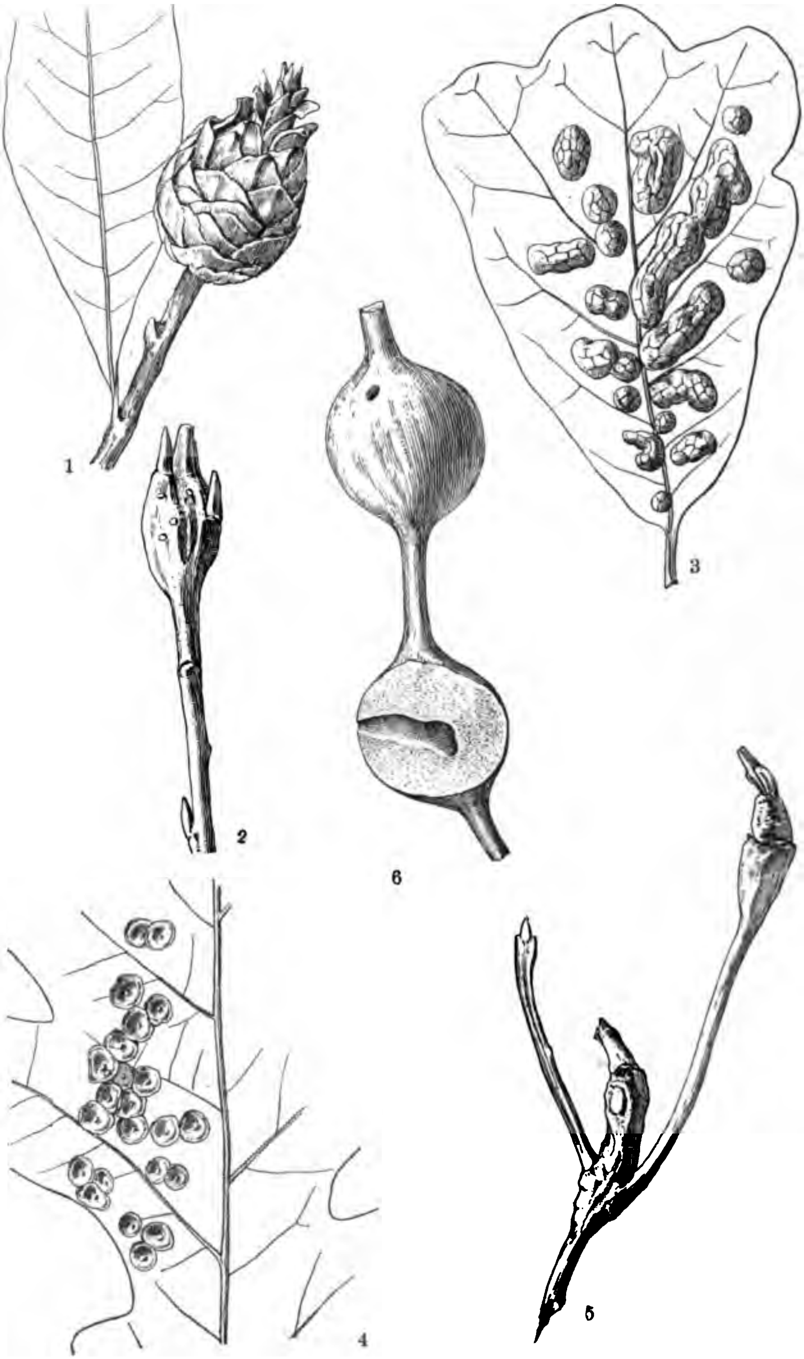
1. Acraspis erinacei Walsh.
2. Neuroterus floccosus Bass.
3. Dryophanta polita Bass.
4. Holcaspis globulus Fitch.
5. " duricoria Bass.
6. Cynips strobilana O. S.



1. Neuroterus batatus Fitch.
2. Andricus petiolicola O. S.
3. Biorhiza forticornis Walsh.
4. Cecidomyia serrulatæ O. S.



1. Cecidomyia holotricha O. S.
2. " caryæcola O. S.
3. Cecidomyia persicoides O. S.
4. " tubicola O. S.



1. Cecidomyia strobiloides O. S.
2. " rigidæ O. S.
3. Cecidomyia pilulæ Walsh.
4. " poculum O. S.
5. Cecidomyia clavula Beut.

1. Pachypsylla venusta O. S.
2. " curcurbita Riley.
3. " gemma Riley.
4. Hormaphis spinosus Shimer.
5. " hamamelidis Fitch.
6. Pemphigus rhois Fitch.
7. Acarus serotinæ Beut.

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Besides the authors' separates, and in addition to the regular edition of the Bulletin, 100 copies were issued in signatures as printed, each signature bearing at the bottom of the first page the date of publication.

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

Volume VI, 1894.

Article I.— ON THE BIRDS OF THE ISLAND OF TRINIDAD.

By FRANK M. CHAPMAN.

The Island of Trinidad is situated at the northeastern extremity of South America, from which it is separated by the Gulf of Paria with its passages to the sea. The southern passage, known as the Serpent's Mouth, is at its narrowest point only seven miles in width. At the northern outlet, or Dragon's Mouth, the same distance intervenes between the Venezuelan headland and Chacachacare, one of the three small islands off the northwest coast of Trinidad.

The average length of Trinidad is forty-eight miles; the average width thirty-five miles. The area, according to Wall and Sawkens, is 1734 square miles, or nearly one and one-half times that of the State of Rhode Island. The northern part of the island is mountainous, the highest peak having an altitude of 3012 feet. Two ranges of hills, running in a generally eastern and western direction, cross the island, one near the middle, the other along the southern coast. The ground between these ranges is, as a rule, rolling and watered with small streams. Only a comparatively small part of the island is under cultivation, the principal products being sugar and cacao. The area devoted to sugar is confined almost entirely to the western coast of the island, while cacao is grown in the valleys of the interior.

The year is divided into two seasons, a wet and a dry. The former generally begins in May and continues until December. The annual rainfall for the whole island, based on numerous observations extending over many years, is given by Dr. de Verteuil as 66.28 in. There is, however, apparently much variation with locality. For example, the rainfall at the Indian Walk Rest-house, at the edge of the forest, for 1891, was 126.17 in., and for 1892, 157.77 in. The latter year, however, was an exceptional one, the rainfall for the island averaging about 120 in. There is comparatively little variation in temperature throughout the year. Observations at the Botanic Gardens in Port-of-Spain show that the mean temperature at 9.30 A. M. ranges from about 78° to 84° F., and at 3.30 P. M. from 77° to 84° F.

During the dry season a fresh trade-wind blows from the eastward. During the rainy season the winds are light and variable.

With these brief introductory remarks on the principal physical and climatic characteristics of the island I proceed to a description of the localities where the collections and observations upon which this paper is based were made.

San Fernando (Feb. 23).—I reached Port-of-Spain, the principal city of Trinidad, February 21, 1893. On the night of the 22d, through the courtesy of the officers of the S. S. 'Alps' I sailed southward on that steamer and anchored the following morning off the city of San Fernando. Here, at the mouth of the Cipero River, I passed a few hours ashore. The locality is quite different from any that I subsequently visited, and brief as was my stay I met with several species which I did not afterward observe. At the entrance of the river into the gulf there are a few mangrove bushes, but a short distance from its mouth sugar-cane fields and meadows or 'savannas' appear. The following birds were seen only at this point: *Synallaxis cinnamomea*, *Leistes guianensis*, *Agelaius icterocephalus*, *Quiscalus lugubris*, *Tachycineta albiventris*.

La Brea (Feb. 23–26).—On the afternoon of the same day we steamed to La Brea and, while loading pitch from the celebrated Pitch Lake, were anchored here until the night of the 26th.

The part of the coast which I saw here is dry and sandy, and a low, dense, scrubby growth, composed largely of different species of palms, reaches to the water's edge. The locality is not a very favorable one for birds. Three species were seen here which were not elsewhere met with. They are: *Chætura polioura*, *Panyptila cayennensis* and *Myiozetetes sulphureus*.

Indian Walk Rest-house (Feb. 28–April 29).—After returning to Port-of-Spain I left on the morning of the 28th for Princestown, about 35 miles to the southward, at the terminus of the railway. Here I secured conveyance for myself and outfit and proceeded to the Indian Walk Rest-house, on the Moruga Road, seven miles southwest of Princestown and twelve miles directly north of the southern shore of the island at Moruga, a point midway between the eastern and western coasts. I resided at the rest-house from February 28 to April 29, making during this time one trip to the coast. The rest-house is a government station in charge of Corporal Stoute, who with his wife well deserves the reputation he has acquired in attending to the wants of the occasional travelers who stop at the rest-house in passing to or from the coast. It is at the border of the primæval forest, which, broken only by a bridle path and a few small clearings, stretches to the southern shore of the island. The locality is an excellent one for land-birds. The cleared ground borders the road, and is devoted to cacao groves, which are in various stages of cultivation from the newly cleared and burned fields to those containing bearing trees. In some neglected groves a growth of grass had sprung up which attracted certain Finches.

The forest is quite typical of the tropics. There is a luxuriant growth of parasitic plants, a confusing tangle of lianes, and many trees reaching to a height of 150 feet.

During the rainy season the region is well watered by numerous small streams, which at the time of my visit were for the most part dry. The varied character of the ground at the rest-house made it a most favorable point for collecting, and while many species known from the island were not seen there, I doubt if a better locality could be found for an observer whose time was necessarily limited. The average temperature during my stay was as follows:

	7 A. M.		2 P. M.		9 P. M.	
	March.	April.	March.	April.	March.	April.
Mean.	64.4°	70°	88°	88°	74°	77°
Highest.	74	75	92	93	78	79
Lowest.	60	65	84	78	70	74

The rainfall, as shown by the government rain-gauge, was, for March 1.85 in.; in April we had 1.82 in. from the 1st to the 22d. On the latter date the rainy season began, and from then to the 28th we had 6.22 in.

Moruga (April 21–24).—April 21 I went to Moruga, on the south coast, returning to the rest-house on the 20th. The way led through the forest and over a broken range of hills running east and west. Corn-birds (*Ostinops* and *Cassicus*), Toucans, Parrots, Plumbeous Kites, and Trogons are the characteristic birds seen in passing along this road. Smaller birds are less common than in partially cleared districts.

At Moruga there is a fine, gently sloping beach on which scarcely a shell is to be seen. At high-tide the water reaches back to rather scrubby woods, or patches of roseau palms, or beats against the precipitous sides of some sandstone headland. One of these promontories, on which were growing old forest trees, was nearly one hundred feet in height, and was being gradually washed away by the encroaching waves. Two small rivers, the Morikeet and Moruga, enter the sea at this point. Both are bordered by mangroves (*Rhizophora*) for some distance from their mouths. Large sand-flats extend from the mouth of the Moruga River, and here were observed a few small Sandpipers and Plovers. Not a Gull, Tern, nor Pelican was seen, and here, as elsewhere on the coasts, I was struck by the scarcity of seabirds. I ascended the Moruga River for some distance, but the hour was not favorable, and I saw comparatively few birds, and only one, *Aramides axillaris*, which had not been previously taken.

Caroni River (May 3).—May 1 I again reached Port-of-Spain, and early on the morning of the 3d passed several hours near the mouth of the Caroni River, which enters the Gulf of Paria a few miles south of that city. The river reaches the gulf through vast mangrove (*Rhizophora*) swamps, and these, with the mud-flats which are exposed at low-tide, are said to form the feeding ground of many water-fowl. At the time of my visit, however, these flats were covered, and beyond a few Brown Pelicans, and a number of Blue Herons (*Ardea cærulea*), White Egrets (*A. egretta*), and Green Herons (*A. cyanura*), water-birds were not abundant. *Dacnis bicolor*, which was not seen elsewhere, was common here in the mangrove bushes.

Monos Island (May 4–7).—The following morning I went to Monos Island, staying at Mr. Morrison's until May 8. The chief object of my visit was to see the famous Gúacharo caves and also to secure specimens of the Fish-eating Bat (*Noctilio leporinus*). Much to my regret I had little time left to explore the island itself, but the brief glimpse I obtained was sufficient to show me that the avifauna of Monos differs markedly from that of the vicinity of the rest-house, and indeed from that of any locality I had previously visited. The vegetation on Monos is entirely unlike that of the southern part of Trinidad. The whole island is covered with a growth of small, slender trees. The woods are rather open, and resemble a northern second-growth forest about twenty years old. It was to be expected, therefore, that many forest-loving species should be wanting, but I was not prepared to find in the short time at my command so many species not met with before. Of the twenty-six species of land-birds seen on Monos the following had not previously been observed: *Saltator albicollis*, *Spinus cucullata*, *Empidochanes cabanisi*, *Sublegatus glaber*, *Myiopatis semifusca*, *Coccyzus americanus*.

Compsothlypis pitiayumi, *Myiarchus tyrannulus*, and *Engyptila verreauxi*, birds which were exceedingly rare at the rest-house, were among the most common species at Monos. The presence of *Saltator albicollis*, *Sublegatus glaber*, and *Spinus cucullata*, species not known south of Venezuela, is perhaps due to the proximity of this part of Trinidad to the mainland, and suggests that comparison of the faunæ of northern and southern Trinidad will show a Venezuelan element in the former that is wanting in the latter, which in turn may show Guianan affinities not present in the northern part of the island.

The Faunal Position of Trinidad.—While the political divisions of the earth's surface are, as a rule, based on purely artificial boundaries, they become in time so strongly fixed in our minds that we frequently ascribe to them a significance they are far from possessing. There can be no better illustration of this than the popular idea of the geographical position of the island of Trinidad. Politically, Trinidad belongs to what are known as the British West Indies; faunally, that is naturally, Trinidad has no connection whatever with the West Indies, but is entirely South American in its affinities. Indeed, both zoölogical and geological evidence place beyond doubt the fact of its recent connection with the mainland. Looking from the northwest point of Trinidad westward past the small detached mountain-islands, Monos, Huevos, and Chacachacare, the mountains of the Venezuelan headland, distant only seven miles from the last named island, may be seen so distinctly that political lines vanish and the whole appears as it really is, a continuous mountain-chain, through whose deep valleys, due to subsidence, the sea now flows.

The continental relationships of Trinidad have been known for many years, and have often been pointed out by both zoölogists and geologists,[1] nevertheless there are many naturalists who consider Trinidad a truly West Indian island, while to the popular mind the initials "B. W. I." irrevocably decide its position. In the paper referred to Mr. Guppy places the time of the disruption of what he has termed the Parian or Northern Range, and the consequent formation of the Bocas and the Gulf of Paria, as subsequent to the close of the Miocene period. The absence of races widely differentiated from their mainland ancestors through insular isolation tends also to show that the continental connection existed at a comparatively recent time. It might be urged that the proximity of Trinidad to the mainland has prevented the complete isolation necessary for the development of new forms. I do not believe, however, that this is true.

[1] See especially a recent paper by Mr. Guppy (Quart. Journ. Geol. Soc., XLVIII, 1892, p. 519), with whose views concerning a supposed Caribbean continent I cannot, however, agree.

The island of Cozumel is situated only twelve miles off the coast of Yucatan, but in spite of its small size and nearness to the mainland it has some sixteen peculiar forms.

Certain migratory birds, for example, *Milvulus tyrannus* (*cf.* Léotaud) annually visit Trinidad, but beyond this migration the passage of birds from the main to the island, or *vice versa*, is apparently infrequent and accidental.

We can thus in a general way determine the relationships of Trinidad to the continent, and it is therefore of special interest to note the effects of this recent insulation on the birds of the island. Unfortunately we have not as yet sufficient exact data from the adjoining main to make a satisfactory comparison, but as before stated, the relationships of the birds of the island to those of the continent are remarkably close. As far as we at present know the following species and subspecies of birds are peculiar to Trinidad or to Trinidad and Tobago :

Merula xanthosceles,	Basileuterus vermivorus olivascens,
Cyclorhis flavipectus,	Lanio lawrenceii,
Chlorospingus leotaudi,	Sporophila lineola trinitatis,
Platyrhynchus mystaceus insularis,	Ramphocænus melanurus trinitatis,
Myrmeciza longipes albiventris,	Amazilia erythronota,
Momotus swainsoni,	Pipile pipile.

Most of these birds are simply insular representatives of mainland species to which they are closely allied. They serve to show that, in spite of its comparatively recent separation and proximity to the continent, Trinidad still presents a habitat sufficiently isolated to permit of the differentiation of some of the species inhabiting it.

An analysis of the distribution of the 199 resident land-birds common to Trinidad and the continent shows that it belongs in the Colombian, rather than in the Amazonian subregion. Thus 153 of these birds are found in both Guiana and Venezuela, while twenty-five are found in Venezuela but not in Guiana, and only eleven are found in Guiana but not in Venezuela.

The relationships of Tobago to Trinidad are much the same as are those of the latter island to the mainland. Tobago was probably joined to Trinidad at the time of the continental connection previously mentioned, and its separation may have occurred at the time when, as Mr. Guppy has shown, the Bocas were formed through subsidence.

In a previous paper[1] I stated that Tobago had no birds not found in Trinidad. Subsequent investigation proves this statement to be erroneous. Most of the birds found there are identical with those of Trinidad, but the much smaller size of the island has tended to restrict the avifauna. There is an excellent opportunity here, for one familiar with both islands and their birds, to determine some of the causes which govern the distribution of species. For instance, Trinidad is exceedingly rich in Falconidæ, of which twenty-one species have been found in the island. Tobago, on the other hand, has only three species, and such common birds as *Cathartes* and *Catharista* are among the missing. Local conditions, perhaps insufficient food-supply, may be the cause in this case, but the real cause can be determined only by observation. The species found in Tobago, but which are as yet unknown from Trinidad, are the following: *Mimus gilvus*, *Chiroxiphia pareola*, *Campylopterus ensipennis*, *Centurus tricolor*, *Sittasomus olivaceus*, *Ortalis ruficauda*. These are all South American species, some of which may still be found in Trinidad.

The relationships of Grenada, the most southern of the Antilles, to Trinidad have been briefly considered in a previous paper.[1] The distinctness of its avifauna from that of Trinidad would seem to indicate that no connection has existed between the two islands.

The South American element in the avifauna of Trinidad, Tobago, and Grenada is shown by the following table, in which are scheduled only the resident South American land-birds, or their representatives, which occur in each:

	Trinidad.	Tobago.	Grenada.
Tinamidæ	1		
Cracidæ	1	1	
Columbidæ	7	4	
Falconidæ	21	3	1
Strigidæ	4		
Psittacidæ	5	1	

[1] Bull. Am. Mus. Nat. Hist., Vol. IV, p. 322.

	Trinidad.	Tobago.	Grenada.
Cuculidæ	6	1	1
Trogonidæ	3	1	
Alcedinidæ	4	1	
Galbulidæ	1	1	
Momotidæ	1	1	
Ramphastidæ	1		
Picidæ	5	3	
Caprimulgidæ	5	3	
Cypselidæ	6	1	2
Trochilidæ	17	6	1
Formicariidæ	9	3	
Dendrocolaptidæ	11	5	
Cotingidæ	4	3	
Pipridæ	2	1	
Tyrannidæ	24	7	4
Icteridæ	8	3	1
Fringillidæ	8	4	1
Tanagridæ	18	2	1
Hirundinidæ	4		
Vireonidæ	3	2	1
Cœrebidæ	6	4	
Mniotiltidæ	3		
Troglodytidæ	2	2	1
Turdidæ	5	2	2
Total	195	65	16

Bibliography of the Trinidad Avifauna.—The first paper of importance relating to the birds of Trinidad was published in Dr. de Verteuil's 'Trinidad, its Geography, Resources, etc.,' in 1858. This, the first edition of this work, I have not seen. According to Coues (Orn. Bibl.) the ornithological matter appeared on pages 118–126 and 423–429. In the second edition[1] I believe the same matter is given on pages 89–97 and 365–381. The first article is by Dr. de Verteuil, and treats in a general way of the better known species; the second article is entitled, 'An Essay on the Ornithology of Trinidad,' by Antoine Léotaud, M.D.P. A nominal list of species is followed by some general remarks on the avifauna of the island, 'Nidification,' 'Migration,' 'Game,' 'Note and Song.'

In 1864 this was followed by a paper by Mr. E. C. Taylor[2]

[1] Trinidad: Its Geography, Natural Resources, Administration, Present Condition and Prospects. By L. A. A. de Verteuil, M.D.P.....Second Edition. Cassell & Company, Limited. London, Paris and New York. 1884. 8vo. pp. i–xi, 1–484.
[2] Ibis, 1864, pp. 73–97.

based on observations made between December 22, 1862, and March 24, 1863. During this time Mr. Taylor traveled over the greater part of the island, and also visited the mainland. As a result of his explorations in Trinidad, he gives an annotated list, consisting of 109 species of land-birds and nine species of water-birds. Two years later Dr. Léotaud's important work[1] appeared. Later writers (see Sclater and Finsch) have correctly estimated the value of this work to science. It was published at a time when papers on South American ornithology based on personal observations were limited in number, and Dr. Léotaud's many years of field experience gave him advantages which few ornithologists had possessed.

At the time when Dr. Léotaud worked the correct identification of tropical birds was possible only for a few specialists. There were no general works, and a large library was a necessary adjunct to the satisfactory determination of species. With few books at his command it was to be expected that Dr Léotaud would sometimes wrongly identify his specimens. Indeed, these errors indicate the difficulties under which he labored, and as such give evidence of the enthusiasm which enabled him to complete his work. Dr. Léotaud gave 297 species, of which 208 are land-birds and 89 water-birds. Adding to this number four species of land-birds recorded by Taylor, but not mentioned by Léotaud, the total number of species known from the Trinidad fauna in 1866 was 301.

The following year Dr. Sclater[2] published a review of Dr. Léotaud's work, in which he made some general remarks on its character, and corrected in detail a number of misidentifications.

In 1870[3] Dr. Finsch published an extended paper on Trinidad birds based on a collection of 115 species brought from the island by a captain of a vessel. In this collection Dr. Finsch found no less than ten species which had not been recorded by either Taylor or Léotaud, and, I may add, have not been met with by subsequent observers. Among this number were: *Sturnella*

[1] Oiseaux de l'ile de la Trinidad (Antilles), par A. Léotaud, Docteur en Médecine de la Faculté de Paris; Membre Correspondant de la Société de Médecine de Gand. Ouvrage publié par souscription nationale. Port d'Espagne: Chronicle Publishing Office. 1866. Roy. 8vo. pp. i–xx; 1–560; i–iv.
[2] Ibis, 1867, pp. 104–108.
[3] P. Z. S., 1870, pp. 552–589.

hippocrepis, *Icterus vulgaris*, *Cardinalis phœniceus*, *Sycalis brasiliensis*, *Ramphastos erythrorhynchus*, etc. The fact that so many conspicuous birds could have escaped the long-continued observations of Dr. Léotaud, and also that Taylor asserts specifically that some of them do not occur in Trinidad, aroused my suspicions as to the correctness of their alleged place of capture. These suspicions were more than confirmed by Sylvester Devenish, Esq., and H. Caracciolo, Esq., gentlemen well qualified to know, who informed me that previous to the recent passage of laws prohibiting the killing and exportation of birds, hundreds of thousands of bird skins were received in Trinidad from the mainland and thence reshipped to the marts of Europe for sale as millinery or decorative specimens.

It is obvious, therefore, that although a bird's skin may have come directly from Trinidad, it does not necessarily follow that the bird was killed in that island. Thus the many millinery skins existing in collections labeled with the general locality "Trinidad" or "Trinidad make," may or may not have come from Trinidad, and the doubt makes them valueless for purposes of exact comparison. In the case of Dr. Finsch this is particularly unfortunate, for he makes his collection the occasion for extended comparison between "Trinidad" birds and their representatives on the continent.

It is evident from the presence of some species, *e.g.*, *Momotus*, that some of Dr. Finsch's specimens were actually taken in Trinidad, but the presence of the species cited above makes the locality of them all open to question, and, much to my regret, I must ignore Dr. Finsch's paper in the present connection.

Dr. Finsch gives a table of thirty species, which are included in Dr. Sclater's 'Catalogue of American Birds,' as from Trinidad. The fact that twenty-six of these were not observed by either Mr. Taylor, Dr. Léotaud or myself, strengthens my opinion that many so-called 'Trinidad' birds in reality were not killed in that island. For this reason I admit no species in the following list of Trinidad birds unless its claim to rank as such is based on accurate data.

As far as I know, no other papers relating especially to the Trinidad avifauna appeared until 1884, when Mr. Ridgway published a nominal list[1] of fifteen species taken on and near Monos Island by the Naturalists of the U. S. Fish Commission S.S. 'Albatross,' from January 30 to February 2, 1884.

In the same year also a second edition of Dr. Verteuil's book appeared containing the late Dr. Léotaud's paper on Trinidad ornithology, as above mentioned.

The present paper is based primarily on collections made by myself from February 23 to May 7, 1893, under circumstances previously explained. During this time I identified 136 species of land-birds and fifteen of water-birds, of which five appear to be new to the island. In addition I am enabled to incorporate the results of an examination of Dr. Léotaud's collection of birds, which is on exhibition in the Victoria Institute, Port-of-Spain, where, through the courtesy of the authorities of the Institute, I was given every opportunity to study it. The specimens are all mounted, and, except for injury due to the continued exposure to the light, are, as a rule, in excellent condition. They are labeled with numbers corresponding to those given by Dr. Léotaud in his work, and the sex is generally given, but there is no further record. I regret that an entire absence of books, except Dr. Léotaud's, and of material for comparison, prevented my examination of these specimens being in every instance satisfactory. It was made, however, after I had practically completed my own collections, and I brought with me to the Institute specimens of the more obscure species for comparison with Dr. Léotaud's. In this way I was enabled to identify a number of Dr. Léotaud's species, the correct names of which have previously been unknown. As far as my own collections go, and in the case of North American species, my identification of Dr. Léotaud's birds may, I think, be accepted.

Additions to the Trinidad Avifauna.—The following species do not appear to have been previously recorded from Trinidad: *Dysithamnus mentalis spodionotus, Sclerurus albigularis, Sublegatus glaber, Myiozetetes sulphureus, Chlorospingus leotaudi* (sp. nov.).

Species Described as New and Changes in Nomenclature.—The following new or emended names are proposed in the present

[1] Proc. U. S. Nat. Mus., VII, p. 173.

paper: *Pipile pipile* Jacq. proves not to be synonymous with *P. cumanensis* of the same author; *Myrmeciza longipes albiventris* is described as new; *Ramphocænus melanurus trinitatis* (Less.) is given subspecific rank; *Empidochanes arenaceus* Scl. & Salv. apparently becomes a synonym of the previously described *E. cabanisi* Léotaud; the Tobagan form of this genus is described as *Empidochanes cabanisi canescens*; *Myiarchus coalei* Ridgw. is considered inseparable from *M. tuberculifer* d'Orb. & Lafr.; *Chlorospingus leotaudi*[1] and *Basileuterus vermivorus olivascens*[1] are described as new. *Cyclorhis flavipectus trinitatis* Allen is shown to be a synonym of *C. flavipectus* Scl.; and *Troglodytes tobagensis* Lawr. is not considered separable from *T. rufulus*.

During my entire trip I was everywhere received with so much courtesy that I find it difficult to properly express my appreciation of the assistance which was always graciously rendered me. To the following gentlemen I am especially indebted for favors which contributed materially to whatever success has attended my efforts: Captain Byers and Chief Engineer Walker of the Trinidad Line of Steamers; Harry Vincent, Esq., Trinidad's Commissioner to the World's Fair; William Cunningham, Esq., formerly of Port-of-Spain; H. Caracciolo, Esq., President of the Trinidad Field Naturalists' Club; and Henry C. Warner, Esq., Warden of Savanna Grande.

I.—General Remarks on Trinidad Bird-life.

The following remarks are based principally on my experience at the rest-house, where a residence of two months permitted me to become fairly familiar with the birds of a limited area, but nevertheless an area which seemed to present many phases of tropical bird-life.

Number of Species.—During my stay at the rest-house I identified 115 species of resident land-birds. In addition to this number I observed or heard at least six species which I did not secure. No additions were made to my list after the first month, and I think the number given fairly represents the avifauna of the

[1] A preliminary description was published in 'The Auk,' 1893, p. 342.

locality during March and April. With one or two exceptions these birds were found within half-a-mile of the rest-house, and the richness of the avifauna will therefore be readily seen.

The average number of birds seen daily was fifty-six. If, however, I visited ground of varying character the number of species observed in a single day might reach seventy. The 115 species recorded may be classed according to their relative numbers as follows: Abundant, 14; common, 45; tolerably common, 26; rare, 30. In considering these figures my unfamiliarity with the avifauna and the difficulty with which some birds were observed must of course be taken into account.

While the presence of birds in large numbers was dependent upon the supply of food, bird-life was nevertheless very generally distributed, and there was comparatively little variation in the number of birds seen daily.

Migration.—Using the word in its restricted sense, the migratory birds which regularly visit Trinidad are too few in number to make any impression upon the character of the land-bird avifauna, which, as a whole, is apparently much the same throughout the year. There are a few species, notably *Milvulus tyrannus*, which come from the mainland in the summer, or wet season, and return to the continent for the winter, or dry season, but as a rule the land-birds of the island are resident.

Although my observations covered so brief a period they gave me some idea of the fluctuations in tropical bird-life due to food-supply.

It is a well-known fact that a large class of tropical birds consists of fruit and flower feeding species, whose presence is dependent upon the flowering of certain trees or the ripening of their favorite fruits.

On my arrival at the rest-house, March 1, the *bois immortel* trees (*Erythrina coccinea*) were in full bloom. Among the birds which were attracted to their blossoms, Hummingbirds and Blue Honey-creepers (*Arbelorhina cyanea* and *A. cærulea*) were especially abundant. March 15 the blossoms had almost disappeared, and from that date until my departure some of the Hummingbirds previously so common were not observed again, while the Honey-creepers, which had been as abundant as swarming bees, were rarely seen. Doubtless they were attracted to some fresh food which took them beyond the boundaries of my field of observation. At Monos Island I was told that some species, Pigeons among the number, are drawn from the mainland to Trinidad by the ripening of certain fruits. Instances of this kind, however, probably occur only among the roving species possessed of extended powers of flight.

With the exception of shore-birds few North American migrants visit Trinidad. The island is beyond their line of flight. Four species of Ducks, one of Rail, and twenty-nine species of Snipes and Plovers, show that the island is a winter resort for some of our water-birds, but of land-birds only the following have been recorded: *Coccyzus americanus*, *Coccyzus erythrophthalmus*, *Ceryle alcyon*, *Spiza americana*, *Piranga rubra*, *Chelidon erythrogaster*, *Protonotaria citrea*, *Dendroica æstiva*, *Seiurus noveboracensis* and *Setophaga ruticilla*. Of these *Spiza americana* and *Protonotaria citrea* have not been recorded from the Lesser Antilles, and the occurrence of the former indicates the probability of their having reached Trinidad from Venezuela.

The remaining seven species are more or less common in the Lesser Antilles, and their presence in Trinidad is in support of Prof. Julien's[1] observations on the arrival of birds in the island of Sombrero from the northwest.

Indeed it seems not improbable that, as Prof. Julien has suggested, some of these birds may have reached Sombrero by a direct flight from the Bermudas, a distance of over 800 miles.

Acccording to Reid, the land-birds which visit the Bermudas with more or less regularity are *Ceryle alcyon*, *Coccyzus americanus*, *Chordeiles virginianus*, *Dolichonyx oryzivorus* and *Seiurus noveboracensis*. The North American land-birds recorded by Prof. Julien from Sombrero are: *Setophaga ruticilla*, *Chelidon erythrogaster*, *Dolichonyx oryzivorus* and *Coccyzus americanus*. Passing southward to Grenada, the last of the Antillean chain, we find the following North American land-birds recorded from that island by Wells:[2] *Ceryle alcyon*, *Dolichonyx oryzivorus*, *Chelidon*

[1] *Cf.* Ann. Lyc. Nat. Hist. New York, VIII, 1864, p. 93.
[2] Proc. U. S. Nat. Museum, IX, 1886, p. 609.

erythrogaster, *Setophaga ruticilla* and *Seiurus noveboracensis*. Thus the five North American land-birds which occur more or less regularly in the Bermudas represent 50% of those which have been recorded from Sombrero, 60% of those known from Grenada, and three of the five have been taken in Trinidad. This rather remarkable agreement in numbers and species of migrants visiting these islands would seem to imply a direct flight from the Bermudas to Sombrero, and thence southward through the islands. It is true that all the regular Bermudan migrants, except *Dolichonyx*, have been found in Porto Rico, and while many North American species winter in that island, others no doubt pass southward through the Lesser Antilles. Nevertheless the observations of Prof. Julien, and the facts just cited are strong evidence in support of a regular migration of birds from the Bermudas to the northern Lesser Antilles, the longest flight, as far as I know, made by migrating birds.

Call-Notes and Songs.—Probably the most fascinating part of one's experience in a new avifauna consists in learning the notes of species which he has not previously observed. This pleasure is of course heightened as increasing familiarity with living birds gives additional data for comparison.

After returning from my first outing in Trinidad forests my mind was so confused by the great variety of strange calls, cries, and whistles that I had clear impressions of the notes of but few birds. Except for the advantage of knowing most of the birds as 'skins,' it was very much like beginning the study of field ornithology over again. After I had learned to recognize birds by their notes I was struck by three things, the first of which has been commented on by most writers on tropical birds; that is, the comparative absence of singing birds. Of the 115 land-birds seen at the rest-house only three had songs which were sustained more than a few seconds. They are a Thrush (*Merula gymnophthalma*), a small Tanager (*Euphonia violacea*), and a Finch (*Sporophila grisea*). To this number may be added a number of species which would come under the general head of song-birds, though their vocal efforts are restricted to a few notes, which are not sung continuously. The leaders among these are *Troglodytes* *rufulus*, *Thryothorus rutilus*, *Cyclorhis flavipectus*, *Geothlypis æquinoctialis*, *Basileuterus vermivorus olivascens* and *Vireo chivi agilis*. There are others which, strictly speaking, should be ranked as song-birds, but their notes are too insignificant to make them prominent. But the class of birds whose notes give character to the avifauna are not true song-birds, though species are included which possess more vocal ability than many birds so classed. These birds, however, do not sing, but squeak, squawk, chuckle, whistle, chatter, quack, scream, or coo, in fact make all manner of sounds musical and unmusical. The principle species in this class are the Tanagers (*Ramphocelus* and *Tanagra*), the Cassiques (*Ostinops* and *Cassicus*), *Icterus*, *Pitangus*, *Tyrannus*, *Formicarius*, *Myrmeciza*, *Crotophaga*, *Ramphastos*, Parrots, Trogons, Owls, Doves and Tinamous.

The second thing about the notes of Trinidad birds which impressed me was a generic resemblance in song. For example, any one familiar with the song of the House Wren (*Troglodytes aëdon*) would at once recognize the Trinidad House Wren by its song. In a similar manner the notes of *Vireo chivi agilis*, *Icterus*, *Molothrus*, *Tyrannus*, *Trogon*, *Amazona*, *Chætura*, *Glaucidium*, and the Doves, at once betrayed the generic relationship of the singer. Several of these instances are particularly interesting, giving, as they do, evidence of a common origin, and also of the stability of characteristic calls and songs.

But on the other hand I was struck by the remarkable resemblance among the notes of birds very distantly related. Thus some of the notes of *Synallaxis albescens*, *Thamnophilus doliatus*, *Dendrornis*, and *Trogon meridionalis*, were so like some of those of *Sayornis phœbe*, *Corvus americanus* and *Colaptes auratus*, respectively, that were either bird heard in the habitat of the other its identity would not be suspected.

Nesting.—March 1, when I reached the rest-house, many birds were nesting and young birds were on the wing. May 1, when I left the rest-house, the nesting season had apparently not reached its height.

In the tropics the nesting season is not necessarily governed, as it is in the north, by climatic conditions and the food-supply.

One month is much like another, and a bird may nest in June or December as far as external conditions are concerned. It is worthy of note, therefore, that although a tropical nesting season is less sharply defined than a boreal one, it is nevertheless a nesting season of periodic and regular occurrence.

A comparison of the nests of northern with those of tropical birds shows how much more complex in form are the latter. The eggs and young of tropical birds are exposed to so many dangers which do not threaten those of northern species that special types of nest structure appear to have been evolved as a means of protection. Tree-snakes, lizards, opossums, monkeys, ants, large spiders, and nest-robbing birds are probably the most destructive foes of nesting birds, and the heavy rains of the wet season may destroy the homes of some species.

It is doubtless these causes which have been effective in producing such architectural marvels as the nests of *Ostinops*, *Rhynchocyclus*, *Synallaxis*, and, to go out of Trinidad, the many extraordinary nests of birds throughout the tropics.

I was impressed by the fact that some simple nests, so to speak, were covered and had entrances at the side. For example, *Pitangus* and *Cœreba*. Nests constructed in this way would effectually shed water and thus be habitable during the wet season.

We know as yet comparatively little concerning the nesting habits of tropical birds, and, aside from other reasons, the density of the vegetation, as Dr. Léotaud remarked, often successfully defies the best attempts to discover the treasures the birds have confided to its keeping.

The Colors of Tropical Birds.—In Trinidad I saw alive for the first time many species of birds which had long been familiar to me as 'specimens.' Several of these birds interested me greatly by the display of markings, which in the dried 'skin' are entirely concealed. Thus the white lesser wing-coverts of *Tanagra melanoleucus* were conspicuous when the bird was flying, while the habit of nervously flitting its wings made a similar marking in *Oryzoborus* easily visible. Again the white nuchal collar in *Florisuga* was frequently displayed while the bird was in flight, and my observations on the mating habits of *Thamnophilus major* show, I think, that the white dorsal patch is intentionally displayed.

The relation of color to environment is so complex a subject, and any attempt at its explanation involves so exact a knowledge of the governing causes, that my own brief experience was sufficient only to show me how necessary field experience is to the solution of problems of this kind. Only a close study of the living bird *in a part of its habitat which has not been altered by man's agency* will result in the accumulation of data from which we may rightly attempt to draw conclusions. It seems to me of the utmost importance that a species should be found in what is absolutely a state of nature if we are to appreciate the harmony which exists between it and its environment. In clearing the forests, planting crops, etc., man has brought about a new condition of things to which many species have succumbed, while others apparently have adapted themselves to their changed surroundings. But what the result will be it is too soon for us to say. In the meantime we must go to primæval nature if we are to gain a proper understanding of the life-history of any animal. The forests at the rest-house afforded me such an opportunity, and in even my short visit I was struck by the distribution of bird-life in them.

Forest birds may be placed in five classes, as follows: (1) The birds of the tree-tops. These are largely insect, fruit, or flower-eating species. Honey-creepers and Honey-suckers (*Cœreba*, *Arbelorhina*, *Dacnis* and *Chlorophanes*), Tanagers (*Ramphocelus*, *Tanagra*), Orioles, Parrots and Paroquets, and Hummingbirds, except *Phaëthornis*, *Pygmornis*, and *Glaucis* are characteristic species of this class. (2) The birds of the trees. These are fruit and insect-eating species, which as a rule inhabit the body of the trees rather than their outer branches. They are less active and more sedentary than the birds of the first group. Representative species are *Cyclorhis*, *Saltator*, *Vireo*, *Trogon*, *Myrmotherula*, *Dysithamnus*, and several of the green Flycatchers. (3) The birds of the tree-trunks. These of course are scansorial birds. Examples are *Dendrocincla*, *Dendrornis*, *Picolaptes*, *Dendrobates* and *Chloronerpes*. (4) The birds of the undergrowth. These are generally found about the borders of the forest where the added light permits a denser low growth. Wrens, Thrushes, *Ramphocænus*, *Platyrhynchus*, *Thamnophilus*, *Glaucis*, *Phaëthornis*, and *Pygmornis* may be included here. (5) The birds of the ground. This class contains such purely terrestrial species as *Aramides*, *Heterocnemis*, *Myrmeciza*, *Nyctidromus*, *Engytila*, and Tinamous. Now there is a remarkable agreement in color among the birds of these five groups *inter se*. The first class is composed of the most brilliantly colored birds of the tropics. To their misleading abundance, in what may be termed popular collections of birds, we owe the general belief that tropical birds are generally of bright plumage, whereas the truth is they are greatly exceeded in numbers by plainly colored species. The second class might be called green birds, though they are not all of this color. The remaining classes are, generally speaking, brown birds. Some are black, or black and white, but they are all inconspicuously colored. A comparison of the members of the first group with those of the fourth or fifth, emphasizes the great difference in color which exists between them. In no birds is it better shown than in the Hummers. Those of the first group are famous for the brilliancy of their plumage, while those of the fourth are dull and obscurely colored.

An attempt to explain this distribution of colors opens a wide field for speculation, upon which I confess I hesitate to venture. I believe, however, that the first object of color is concealment. That is, harmony in color between a bird and its immediate surroundings which will result not alone in concealing it from its enemies, but by rendering it less conspicuous will enable it to secure its food.

The colors of the birds I have mentioned are of this nature. The gayly plumaged birds of the first class are brought into contrast with the bright fruit or flowers; those of the second class are generally green like the foliage about them; those of the remaining three classes are for the most part brown like their background of bark or dead leaves.

While it may not be questioned that in their distribution these birds do harmonize in color with their surroundings, it might be suggested that their colors were in some way dependent on their exposure to light. But a consideration of the dull colors of plain-inhabiting species, which, like the brightly-colored tree-top birds, are constantly exposed to the direct rays of the sun, shows apparently that light is here not an active agent.

I do not speak particularly of the birds of the clearings or cacao groves near the rest-house, for the conditions in both these places were not natural, though even here it was evident that birds sought what were approximately their true haunts. For instance, the tops of the blossoming *bois immortel* trees in the cacao groves would be thronged with many species of the first class. Lower down the green Flycatchers lived, while although the brown Hummers (*Phaëthornis*, *Pygmornis*, and *Glaucis*) were frequently seen probing banana blossoms beneath the *bois immortel* trees, I never once saw one feeding from their brilliant blossoms. Where the grass had been permitted to grow in the groves, Finches or brown Synallaxes might be found. Thus, as in the forest, there was a protective resemblance between a bird and its surroundings.

Beyond this claim for the primary importance of protective coloration I do not for the present care to go. The intensity of the struggle for existence reaches its maximum in the tropics. Birds are there beset by so many dangers that survival means perfect harmony with the environment.

II.—A List of the Birds of the Island of Trinidad.

While I believe that the most natural order in which to arrange lists of species of any class of animals is to begin with the lowest forms and end with the highest, most writers on South American birds have followed exactly the opposite plan, and any attempt to change would now result in so much confusion that I have decided to follow the system of previous writers, even though I disapprove of it.

The native English and Creole names given in the present paper have been furnished me by Thomas W. Carr, Esq., of Port-of-Spain. Mr. Carr has for several years been compiling a list of the popular names of Trinidad birds, and has very generously placed a copy of it at my disposal.

The French names are taken from Léotaud's work. The references to 'Léotaud' and 'Taylor' are to the respective works of these authors on Trinidad birds already cited (*antea*, pp. 9, 10). The notes given refer only to my own observations, and the absence of annotations implies that the species was not met with by me.

Order PASSERES.—Perching Birds.

Family TURDIDÆ.—Thrushes.

1. **Merula flavipes** (*Vieill.*).—Yellow-footed Thrush. Grive à patte jaune.

Turdus flavipes Taylor, p. 80; Léotaud, p. 199.

2. **Merula phæopygus** (*Cab.*).—White-throated Thrush. Grive à cravatte.

Turdus phæopigus Léotaud, p. 197.

3. **Merula xanthoscelus** (*Jard.*).—Black-bird. Grive noire.

Turdus xanthoscelus Léotaud, p. 201.

4. **Merula fumigata** (*Licht.*).—Cacao Thrush. Grive des cacaos.

Turdus fumigatus Taylor, p. 80.
Turdus casius Léotaud, p. 204.

Not common.

5. **Merula gymnophthalma** (*Cab.*).—Bare-cheeked Thrush. Grive à paupières jaunes.

Turdus gymnophthalmus Taylor, p. 80.
Turdus nudigenis Léotaud, p. 201.

Common near the borders of the forests and in partial clearings. They are shy, suspicious birds, and some caution is necessary in approaching them. In general appearance they are typically Thrush-like, and their manner of flitting their tail on alighting is exactly like that of a Robin (*Merula migratoria*). Their ordinary call-note is a low *chût* quite unlike the call of any Thrush with whose notes I am familiar.

They began to sing on April 6, and in a few days were in full song. The song is so like that of a Robin that if it was heard in the habitat of that species it would pass as a slightly aberrant Robin's song. It is not quite so loud as the song of the Robin, is lacking in variety, and is sung less continously, but the character is the same.

Family TROGLODYTDÆ.—Wrens.

6. Troglodytes rufulus *Cab.*—God-bird. Rossignol.

Léotaud, p. 170.
Troglodytes tobagensis Lawr. Auk, V, 1888, p. 403.

Both in song and habits this bird resembles our House Wren (*Troglodytes aëdon*). A pair was always to be found near every cabin, and I rarely saw it far from the vicinity of houses. In Port-of-Spain it is not uncommon in the busiest part of the city.

My specimens represent both the gray and brown phases of color. In the former the underparts are whiter, while in the latter they are more or less washed with buffy. In one specimen the under tail-coverts are without bars.

Comparison with the type of *T. tobagensis* shows it to be inseparable from this species.

7. Thryothorus rutilus *Vieill.*—Bush Wren. Rossignol des Halliers.

Taylor, p. 81.
Troglodytes rutilus Léotaud, p. 173.

This is a not uncommon species, but it inhabits the denser undergrowth, and is much more frequently heard than seen. Its song is a loud, musical whistle, delivered with much energy and rapidity.

One of my examples agrees closely with the Panama specimens, and others are so near that there is apparently little doubt that the form from that locality should stand as *Thryothorus rutilus hyperythrus*.

Family MNIOTILTIDÆ.—Wood-Warblers.

8. **Protonotaria citrea** (*Bodd.*).—Prothonotary Warbler. Fauvette à tête jaune.

Mniotilta citrea Léotaud, p. 179.

There is no specimen of this bird in Léotaud's collection.

9. **Compsothlypis pitiayumi** (*Vieill.*).—Golden Sucrier. Sucrier doré.

Mniotilta venusta Léotaud, p. 181.

A rare bird at the rest-house, where it was observed only once, but on Monos Island it was very common.

10. **Dendroica æstiva** (*Gm.*).—Canary. Figuier.

Taylor, p. 81.
Mniotilta petechia Léotaud, p. 176.

About a dozen birds of this species were observed near the rest-house, and several were taken.

11. **Seiurus noveboracensis** (*Gm.*).—Water Thrush. Batte-queue.

Enicocichla noveboracensis Léotaud, p. 175.

Observed on half-a-dozen occasions on the banks of the forest brooks. Several specimens were taken.

12. **Geothlypis æquinoctialis** (*Gm.*).—Manicou.

Taylor, p. 81.
Trichas velatus Léotaud, p. 183.

Not common. I observed it at La Brea, and there were a few pairs at the rest-house. Its song is a low, softly modulated warble of about six double notes, quite unlike the song of *G. trichas*, which species, however, it resembles in habits.

13. **Setophaga ruticilla** (*L.*).—Redstart. Officier.
Taylor, p. 81; Léotaud, p. 248.

14. **Basileuterus vermivorus olivascens** *Chapm.*—Fauvette des halliers.

Trichas bivittatus Lèotaud, p. 184.
Basileuterus vermivorus olivascens Chapm. Auk, X, 1893, p. 343 (preliminary descr.).

Chars. subsp.—Similar to *Basileuterus vermivorus* (Vieill.), but the bill averages larger, and the upper parts are constantly grayer.

Description of Type (No. 58, 974, Am. Mus. Nat. Hist., adult male, Princestown, Trinidad, March 1, 1893; Frank M. Chapman).—Back grayish olive green, exposed surface of wings and tail more brownish, centre of crown reddish brown, the feathers tipped with grayish and bordered by black lines reaching to the neck, which in turn is margined by a narrow, whitish line passing from the base of the bill over the eye; a dusky line through the eye; cheeks and ear-coverts grayish; underparts bright yellow, sides greenish; legs flesh-color; bill brownish black, lighter below. Sexes alike.

Mr. Sharpe (Cat. Bds. B. M., X, p. 393) has called attention to the differences which distinguish the Trinidad bird, and comparison of six specimens from the island with an equal number from the mainland shows the insular form to be well worthy of recognition as a race.

This bird lives in the thickets of second growth or denser undergrowth, but is not common anywhere. Its call-note is a sharp *peek*, while its song is a Dendroica-like *wee-chee-ee-ee*.

Family CŒREBIDÆ.—Honey Creepers.

15. **Cœreba luteola** *Cab.*—Sucrier.

Certhiola luteola Taylor, p. 81; Ridgw. Proc. U. S. N. M. VII, 1884, p. 173.
Certhiola flaveola Léotaud, p. 126.

This was the commonest species observed by me in Trinidad. It is quite generally distributed, and always to be found near blossoming trees, the *bois immortel* proving especially attractive. They are active little birds, in no sense 'Creepers,' but suggesting rather a *Dendroica* in their movements. Their song is an unmusical effort which may be expressed by the syllables *pita, pita, pita, ker-chèr, ker-chèr*.

The nest is a rather bulky affair—of dried grasses and strips of banana bark, having the entrance on the side. It is placed, as a rule, in a thickly-leaved tree, preferably an orange tree, not more than ten feet from the ground. Young just from the nest were seen March 13. A female seen April 6 was gathering nesting material, and another seen April 18 was pulling an old nest to pieces and using the material to build a new one.

16. **Arbelorhina cærulea** (*L.*).—Green-legged Grampo. Grimpereau à pattes soufre.

Cœreba cærulea Taylor, p. 81; Léotaud, p. 120.

This bird, like *A. cyanea*, was abundant in the blooming *bois immortel*, on the blossoms of which it was feeding. But from March 16, when the trees were practically out of bloom, until my departure, I saw only one bird.

17. **Arbelorhina cyanea** (*L.*).— RED-LEGGED GRAMPO. GRIMPEREAU À PATTES ROSES.

Cœreba cyanea TAYLOR, p. 81 ; LÉOTAUD, p. 118.

Early in March, when the *bois immortel* was blooming, this species was exceedingly abundant, feeding on the blossoms of these trees. By March 16th the trees had ceased blooming, and from that date until my departure this species was observed only four times.

18. **Chlorophanes spiza** (*L.*).— BLACK-HEADED GREEN HONEY SUCKER. VERT-VERT À TÊTE NOIRE.

Chlorophanes atricapilla TAYLOR, p. 81.
Dacnis spiza LÉOTAUD, p. 122.

Observed on only three occasions.

19. **Dacnis cayana** (*L.*).—VERDIGREE. VERT DE GRIS.

TAYLOR, p. 81 ; LÉOTAUD, p. 124.

Observed on only two occasions.

20. **Dacnis plumbea** (*Lath.*).—SUCRIER DES MANGLES.

Mniotilta bicolor LÉOTAUD, p. 180.

Found only on the banks of the Caroni River, where it was apparently common. Its song is a pleasant, tinkling warble.

Family VIREONIDÆ.—VIREOS.

21. **Cyclorhis flavipectus** *Scl.*—PIE-GRIÈCHE.

Cyclorhis flavipectus TAYLOR, p. 81 ; LÉOTAUD, p. 263.
Cyclorhis flavipectus trinitatis ALLEN, Bull. Am. Mus. Nat. Hist. II, 1889, p. 131.

A very common and generally distributed species, frequenting the trees in both the forest and partial clearings. It is a most unwearying songster, and its notes can be heard from early morning until late in the afternoon. Its song is a loud and musical whistle, consisting of seven notes delivered with much energy. If one answered the caller it would change the order of its notes until they became a refrain of the ordinary call. At times two birds would respond to each other in this way, continuing the performance for many minutes. Their notes were in a measure suggestive of those of *Vireo noveboracensis*.

The Trinidad bird has been described by Dr. Allen as *Cyclorhis flavipectus trinitatis* (l. c.), but as Dr. Sclater's type of *flavipectus* came from Trinidad (*cf.* orig. descr., P. Z. S., 1858, p. 448, and Cat. Bds. B. M., VIII, p. 320) the name *trinitatis* becomes a pure synonym of that species.

Specimens from Venezuela and Colombia, to which Dr. Allen restricted the name *flavipectus*, seem to me to be inseparable from the Costa Rican *subflavescens*.

22. **Vireo chivi agilis** (*Licht.*).—PETIT SIFFLEUR À TÊTE GRISE.

Vireo olivaceus LÉOTAUD, p. 250.

Common. Its song closely resembles that of *Vireo olivaceus*, but is not so loud, and is delivered more slowly.

Trinidad and Tobago evidently form the northern limit of the range of this species, while *V. calidris* apparently does not nest south of Grenada.

23. **Vireo calidris** (*L.*).—GRAND SIFFLEUR À TÊTE GRISE.

Vireo altiloquus LÉOTAUD, p. 250.

24. **Hylophilus aurantiifrons** *Lawr.*—PETIT GOBE-MOUCHE.

Hylophilus insularis LÉOTAUD, p. 186.

Common in the forests and partial clearings where they frequent the trees. Several are generally seen together flitting about actively and uttering a *cack* note like that of the Ruby-crowned Kinglet. Their song is a warble, composed of six notes and suggesting a part of the song of *V. olivaceus*.

On comparison with the type of *H. aurantiifrons*, my specimens show, as Dr. Gadow has suggested, that the Trinidad bird is not separable from that species.

Family HIRUNDINIDÆ.—Swallows.

25. **Progne chalybea** (*Gm.*).— Martin. Hirondelle noire.

Progne purpurea Léotaud, p. 92.

Observed only at the mouth of the Cipero River, at Moruga, and in the Monos Boca. In the two last-named localities it was common and was nesting in crevices in the rocky cliffs.

26. **Atticora cyanoleuca** (*Vieill.*).—Swallow. Hirondelle à ventre blanc.

Hirundo cyanoleuca Léotaud, p. 90.

27. **Tachycineta albiventris** (*Bodd.*).—Swallow. Hirondelle à dos vert.

Hirundo albiventer Léotaud, p. 91.

Observed only at the mouth of the Cipero, where it was not uncommon.

28. **Chelidon erythrogaster** (*Bodd.*).—Barn Swallow. Hirondelle à ventre roux.

Hirundo rufa Léotaud, p. 88.

29. **Stelgidopteryx uropygialis** (*Lawr.*). — Swallow. Hirondelle à ventre jaune.

Cotyle uropygialis Léotaud, p. 94.

Common on the coast and occasionally seen at the rest-house.

Family TANAGRIDÆ.—Tanagers.

30. **Procnias viridis** *Ill.*— Blue Mantle. Cottinga bleu.

Tersa ventralis Léotaud, p. 257.

31. **Euphonia violacea** (*L.*).—Louis d'or simple.

Taylor, p. 82 ; Léotaud, p. 306.

Not uncommon. This bird easily takes first place among the limited number of Trinidad song-birds. Its song is a sweet, varied warble, which sometimes is continued for a minute or more.

Like the song of *Sporophila grisea*, however, it lacks in volume and can be heard only a short distance.

32. **Euphonia trinitatis** *Strickl.*—Cravat. Louis d'or à cravatte.

Euphonia chlorotica Léotaud, p. 308.

33. **Euphonia nigricollis** (*Vieill.*).—Louis d'or à tête bleu.

Taylor, p. 81.
Euphonia aureata Léotaud, p. 310.

34. **Calliste desmaresti** *Gray.*—Worthless. Vert-vert à tête caco.

Taylor, p. 82; Léotaud, p. 302.

35. **Calliste flaviventris vieilloti** (*Scl.*).—Variegated Tanager. Diable enrhumé.

Calliste vieillotii Taylor, p. 82; Léotaud, p. 303.

Occasionally seen in pairs, threes or fours, but by no means common. They are restless birds, and pass little time in one place unless attracted by their food, which seemed to consist largely of berries. I did not hear them utter a note.

36. **Calliste guttata** (*Cab.*).—Tiger Tanagra. Arrivant.

Taylor, p. 82; Léotaud, p. 305.

37. **Tanagra cana sclateri** (*Berl.*).—Blue-bird. Oiseau bleu.

Tanagra cana Taylor, p. 82.
Tanagra glauca Léotaud, p. 293.
Tanagra sclateri Ridgw. Proc. U. S. N. M. VII, 1884, p. 183.

A very common species. They are very active, restless birds, almost constantly on the move. They seem to prefer trees having little foliage, and alight on the bare branches, pausing only for a moment and then continuing their apparently objectless flight. Their call-note, which they utter when about to take wing, is an unmusical, long-drawn *s-e-e-e-p*, and their song is made up of the same unattractive sound.

On March 15 I saw a nestling of this species following two adults, probably its parents.

38. Tanagra palmarum melanoptera (*Hartl.*).—PALMISTE.

Tanagra melanoptera TAYLOR, p. 82.
Tanagra olivascens LÉOTAUD, p. 295.
Tanagra palmarum RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.

Very common. Pairs and small groups of three to six individuals could be seen at almost any time during the day. They are much on the wing, and resemble *Tanagra c. sclateri* in their nervous restlessness.

They were particularly common in the *bois immortel*, apparently feeding on the blossoms. As a rule they alight on the tops of leafless trees, where they hop actively from limb to limb, flitting both wings and tail, and occasionally breaking into a chorus of song. Their notes resemble those of *sclateri*, and consist of a sharp, metallic call-note which may be written *swer*, while their song is a rambling kind of weak, squeaky warble.

39. Tanagra cyanocephala subcinerea (*Scl.*).—BLUE-HEADED TANAGRA. GROSBEC À TÊTE BLEU.

Tanagra subcinerea LÉOTAUD, p. 296.

40. Ramphocelus jacapa magnirostris (*Lafr.*).—SILVER-BEAK. BEC D'ARGENT.

Ramphocœlus magnirostris TAYLOR, p. 82.
Ramphopis jacapa LÉOTAUD, p. 288.

Very common. Generally four or five were seen together at the borders of second growth or in the *bois immortel*. Like the other Tanagers, they are active, restless birds. The only note I heard is a hoarse *cheep*, very much like the call-note of a Song Sparrow (*Melospiza fasciata*). A nestling attended by the parents was seen on March 13.

41. Piranga rubra (*Linn.*).—SUMMER TANAGER. COTTINGA ROSE.

Pyranga æstiva LÉOTAUD, p. 290.

A specimen in the Léotaud Collection.

42. Piranga hæmalea *S. & G.*—RUFOUS TANAGER. CARDINAL À GROS-BEC.

Pyranga hepatica LÉOTAUD, p. 291.

One specimen, apparently of this species, is in the Léotaud Collection.

43. Phœnicothraupis rubra (*Vieill.*).—CARDINAL.

TAYLOR, p. 82.
Tachyphonus ruber LÉOTAUD, p. 297.

Not uncommon. Unlike the other Tanagers, it was never seen in the clearings, but was found only in the forests, where it lives near the ground. In the subdued light of these localities the male appears to be brown in color. Their call is a sharp, pebbly, clicking note, which sometimes becomes a long, rolling call. They are shy birds, and can be approached only by using caution.

44. Lanio lawrencei (*Scl.*).

Tachyphonus atricapillus LAWR. Proc. Acad. Nat. Sci. Phila. 1868, p. 360.
Lanio lawrencei SCL. Ibis, 1885, p. 272, Pl. vi, Fig. 2.

The type of this bird, which Mr. Lawrence definitely states was killed by Mr. Alexander in Trinidad, still remains unique. I follow Dr. Sclater in placing it in *Lanio*, though, as far as one can judge from this single immature specimen, it has little affinity in color with the members of that genus.

45. Tachyphonus luctuosus *Lafr.* — LITTLE PARSON. PETIT PÈRE NOIR.

Tachyphonus albispecularis LÉOTAUD, p. 300.

46. Tachyphonus rufus (*Bodd.*).—PARSON. PÈRE NOIR.

Tachyphonus melaleucus TAYLOR, p. 82; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Tachyphonus beauperthuyi LÉOTAUD, p. 299.

Very common. They were generally seen in pairs which frequented the partial clearings and cacao groves. While perching they maintain a constant nervous flitting of the wings, an action which in the male shows the white lining of the wings conspicuously. The same mark is seen when the bird is flying.

47. Chlorospingus leotaudi *Chapm.*

Chlorospingus leotaudi CHAPM. Auk, X, 1893, p. 343.

Char. sp.—Apparently most like *C. chrysogaster* Tacz. in coloration, but much smaller, and with a larger bill.

Description of Type (Coll. Am. Mus. No. 59,051, female, Princestown, Trinidad, March 28, 1893; Frank M. Chapman).—Crown and nape cinereous, washed with olive green; back bright olive green; wings and tail fuscous, the exposed margins of the feathers olive green; auriculars cinereous; throat and upper part of the breast pale grayish white, rest of the underparts bright yellow; bill horn-black; feet brownish black. Wing, 2.40; tail, 2.25; exposed culmen, .50; height of bill at anterior margin of nostril, .22 in.

I have not seen a specimen of *C. chrysogaster*, described by Taczanowski from Peru. While evidently near *C. leotaudi*, it belongs in the small-billed section of the genus (subgenus *Hemispingus*), and Taczanowski remarks that it is one of the smallest-billed species of the genus. *C. leotaudi*, on the contrary, belongs in the large-billed section, and has a bill as large as any species with which I am familiar. Compared with *C. rubrirostris*, the bill is thicker, and horn-color instead of red; the cinereous of the head does not extend as far down the nape, and the grayish white does not reach so far down the breast. I have named this apparently distinct species in honor of the late Dr. Léotaud, in recognition of his devotion to the study of ornithology.

The specimen described was secured in the forest, and was the only one observed.

48. Saltator albicollis *Vieill.*—Gros-bec tacheté.

Saltator striatipectus Léotaud, p. 286.

This species was observed only on Monos Island, where it was common.

49. Saltator olivascens *Cab.*—Gros-bec.

Taylor, p. 83.
Saltator icterophrys Léotaud, p. 285.

A common species at the borders of the forest, where it frequented the tree-tops. Its song is unmusical, but possessed of decided character, and it is rather singular that it has not served as the basis for a popular name. It may be almost exactly expressed by the syllables *pitt-qùit-you*, *sit-qùat-you*, followed by some indeterminate warbling.

Family FRINGILLIDÆ.—FINCHES, SPARROWS, ETC.

50. **Spinus cucullata** (*Swains.*).—COLORADO.

Two individuals were seen on Monos feeding on the fruit of a large cactus. They are said to be common there at times.

This species is given by neither Taylor nor Léotaud, but 'Trinidad' specimens are included in the Catalogue of the Birds of the British Museum, Volume XII.

51. **Spiza americana** (*Gm.*).—DICKCISSEL. MOINEAU.

Euspiza americana LÉOTAUD, p. 314.

There are three specimens of this bird in the Léotaud Collection.

52. **Volatinia jacarini splendens** (*Bp.*).—BLACK FINCH. PETIT ÇIÇI-ZÈBE NOIR.

Volatinia jacarina TAYLOR, p. 83.
Tiaris jacarini LÉOTAUD, p. 312.

Common in flocks in the grasses of uncultivated cacao groves. The white shoulder-mark can be seen when the bird is on the wing.

While *en route* from Trinidad to Grenada a female of this species boarded our steamer. We were then about halfway between the islands. The bird was in an exhausted condition, and was caught without difficulty. We anchored about half a mile off the harbor of St. Georges, Grenada, where I have no doubt the bird went ashore, as I did not see it after leaving the island.

This instance is of interest in showing how certain South American species may have originally been introduced on islands near the mainland.

53. **Sporophila grisea** (*Gm.*). — GRASSBIRD. ÇIÇI-ZÈBE GRIS.

Spermophila intermedia TAYLOR, p. 83.
Spermophila cinereola LÉOTAUD, p. 319.

Common, frequenting the same localities in which *O. torridus* was found.

This was one of the few birds met with which deserves the name of songster. Its song is musical, varied and well-sustained, and reminded me of the songs of both a Mocking-bird and a Canary. If this song possessed volume the bird would take high rank as a vocalist, but unfortunately it is uttered in such a weak tone that it is not audible more than 100 feet. Furthermore, the bird does not seem to sing frequently, and its song is, therefore, apparently unknown to the natives.

54. **Sporophila lineola trinitatis** (*Sharpe*).—GRASSBIRD. ÇIÇI-ZÈBE À CRAVATTE NOIRE.

Spermophila bouvronoides LÉOTAUD, p. 318.

55. **Sporophila gutturalis** (*Licht.*).— GRASSBIRD. ÇIÇI-ZÈBE À VENTRE JAUNE.

Spermophila gutturalis LÉOTAUD, p. 321.

Observed on five occasions.

56. **Sporophila minuta** (*L.*). — GRASSBIRD. ÇIÇI-ZÈBE À VENTRE ROUX.

Spermophila minuta TAYLOR, p. 83 ; LÉOTAUD, p. 322.

There was comparatively little ground near the rest-house suitable for Finches, and this species was observed on five occasions.

57. **Oryzoborus torridus** (*Scop.*).—ÇIÇI-ZÈBE À DOS NOIR.

Pitylus torridus LÉOTAUD, p. 283.

Common near the borders of low, bushy second-growth, in which, on being alarmed, it sought refuge. When perched it frequently flits its wings in a quick, nervous manner, and this action displays conspicuously their white under surface. I heard no call-note or song from this species.

58. **Oryzoborus crassirostris** (*Gm.*).—GRASSBIRD. GROS ÇIÇI-ZÈBE NOIR.

Spermophila crassirostris LÉOTAUD, p. 316.

Only one was secured.

Family ICTERIDÆ.—Blackbirds, Orioles, Cassiques, etc.

59. Ostinops decumanus (*Pall.*).—Cassique. Caçique huppé.

Ostinops cristatus Taylor, p. 83.
Cacicus cristatus Léotaud, p. 271.

Locally common in the forests. The life-history of this species would no doubt fill a volume. It is a bird of marked character, and its notes and habits are of more than usual interest. There were no birds resident in the immediate vicinity of the rest-house, and for this reason I had no opportunity to study the species closely. During March and April they were nesting. Their nests were generally placed at the extremity of the upper branches of forest trees. In riding from the rest-house through the forest to Moruga, a distance of twelve miles, I saw some fifteen trees bearing nests of *Ostinops*, all of which were apparently occupied. One tree held twenty-six of these long, pendulous structures, and in addition six nests of *Cassicus*. The largest nest I measured was four feet in length. In building them the birds seem to work from the inside. They enter the holes very quickly, in reality flying into them.

Henry C. Warner, Esq., the Warden of Savanna Grande, who has had many years experience in Trinidad forests, called my attention to the fact that these birds nearly always place their nests upon a tree having a smooth bark, and I noted only one exception to this apparent rule. The object of the birds in selecting trees of this nature is presumably to find security from the attacks of tree-snakes or nest-robbing mammalia.

The notes of these birds are among the strangest I have ever heard. Many of them suggest the singular vocal performances of the Great-tailed Grackle (*Quiscalus macrourus*). They squeak, squawk, quack, chuckle and whistle in indescribable ways. The male, bending his head low and ruffling his plumage, utters a long-drawn, creaking call, which resembles the sound produced by chafing trees in a gale. Then he strikes his wings together over his back, producing a crackling sound like the snapping of branches. Other notes are as mellow as those of a cuckoo-clock. When flying their rapid wing-beats sound like the paddles of a distant side-wheel steamer striking the water.

Their favorite food consisted of the fruit of the 'agalee' or 'cupey' tree.

60. **Cassicus persicus** (*L.*).—CORNBIRD. MERLE À CROUPION JAUNE.

TAYLOR, p. 84; LÉOTAUD, p. 273.

This species was found in about the same numbers as *Ostinops decumanus*, which it resembles in habits. Its notes are somewhat similar in character to those of that species, but are easily distinguishable. Its nests are much smaller than those of *Ostinops*, and measure about one foot in length. Young, just from the nest, were seen March 10, but the species was still nesting late in April.

61. **Icterus xanthornus** (*Gm.*).—CAROUGE.

TAYLOR, p. 84; LÉOTAUD, p. 275.

Common about cacao groves and partial clearings. They are particularly fond of the blossoms of the banana, and also frequent the blooming immortel trees. Their song consists of six high flute-like notes, but they rarely sing more than two notes at a time. Their call-note is a sharp, harsh *weet, weet.* Several nests seen on Monos Island were pendulous, one foot in length, and were placed about twenty-five feet from the ground.

62. **Molothrus atro-nitens** (*Cab.*).—LITTLE BLACK STARE. PETIT MERLE NOIR.

Molothrus bonariensis LÉOTAUD, p. 277.

Not common. The note of the male is a bubbling twitter, sufficiently like that of *M. ater* to show at once the generic relationship of the singer.

63. **Agelaius icterocephalus** (*L.*).—YELLOW-HEADED CAROUGE. MERLE À TÊTE JAUNE.

Xanthosomus icterocephalus TAYLOR, p. 84.
Chrysomus icterocephalus LÉOTAUD, p. 281.

Seen only at the mouth of the Cipero.

64. Liestes guianensis (*L.*).— SOLDIER-BIRD. ROUGE-GORGE.

TAYLOR, p. 84.
Leistes americanus LÉOTAUD, p. 279.

A few were seen at the mouth of the Cipero.

65. Quiscalus lugubris *Swains.*—TRINIDAD BOAT-TAIL. MERLE À QUEUE EN BATEAU.

TAYLOR, p. 84.
Quiscalus barita LÉOTAUD, p. 268.

This bird was taken only at the mouth of the Cipero.

66. Cassidix oryzivora (*Gm.*).—BLACK CORN-BIRD. TAÏ-RICO.

Scaphidurus ater LÉOTAUD, p. 269.

Not uncommon in or near cornfields. The only note I heard was of a cracked, reedy character. An adult male in full breeding plumage has the feathers of the sides of the neck much lengthened, forming, when erected, a ruff an inch in length.

Family TYRANNIDÆ.—FLYCATCHERS.

67. Fluvicola pica (*Bodd.*).—WIDOW. VEUVE.

TAYLOR, p. 85 ; LÉOTAUD, p. 205.

Common at the mouth of the Cipero, but only a few were observed near the rest-house, where they frequented the vicinity of brooks in the forest. They seemed to be silent birds, and on no occasion did I hear them utter a note.

68. Arundinicola leucocephala (*L.*).—WHITE-HEADED WIDOW. VEUVE À TÊTE BLANCHE.

LÉOTAUD, p. 207.

Two were observed at the mouth of the Cipero.

69. Platyrhynchus mystaceus insularis *Allen.*—BROAD-BILL. GOBE-MOUCHE À BEC PLAT.

Platyrhynchus cancromus LÉOTAUD, p. 243.

A rather rare species. It frequents the denser undergrowth in the forests, where even on the brightest days a semi-gloom prevails. Its note is a sharp, unexpectedly loud *peek.*

The nature of this bird's haunts suggests that its remarkably broad bill and large mouth may assist it in catching insects, and that they are thus analogous to the large mouth and rictal bristles of the night-feeding Caprimulgidæ.

70. Mionectes olivaceus *Lawr.*—GOBE-MOUCHE VERT.

Elania striaticollis LÉOTAUD, p. 238.

There is one specimen in the Léotaud Collection. I have compared it with the type of *M. olivaceus* Lawr.

71. Mionectes oleagineus (*Licht.*).—GOBE-MOUCHE ROUSSÂTRE.

TAYLOR, p, 85.
Elania oleaginea LÉOTAUD, p. 235.

A not common species, frequenting second-growth.

72. Myiopatis semifusca (*Scl.*).

Phyllomyias semifusca TAYLOR, p. 86.

I found this species only on Monos Island.

73. Ornithion pusillum (*Cab.*).—PETIT TILLON.

Camptostoma imberbe TAYLOR, p. 86.
Myiopatis pusilla LÉOTAUD, p. 234.

Not common. It seems to be more of a gleaner, like the Vireos, than a typical Flycatcher. Its note is a musical *tee-oo.*

74. Elainea gaimardi (*d'Orb.*). — PETIT TILLON À HUPPE BLANCHE.

Elania fallax LÉOTAUD, p. 236.

A common species in the forests, second-growth and cacao groves. Its call is a soft *pee-a-wee,* which might be easily mistaken for that of *Contopus virens.*

75. Elainea pagana (*Licht.*).—WHITE-TUFTED PETCHARY. TILLON.

TAYLOR, p. 86.
Myiobius martinicus LÉOTAUD, p. 224.

A very common species at the borders of the forests and in the cacao groves. It is an active bird, and with crest erect seems to be constantly on the alert. Its notes, consisting of a hoarse, scolding whistle, followed by a Phœbe-like chattering, are frequently uttered. It is by no means a typical Flycatcher, but seems to feed quite as much on fruit as on insects. A female shot on April 14 was laying.

76. **Legatus albicollis** (*Vieill.*). — BLACK-BANDED PET-CHARY. GOBE-MOUCHE À BANDEAU.

Myiobius leucophaius LÉOTAUD, p. 227.

There is one specimen in the Léotaud Collection.

77. **Sublegatus glaber** *Scl.*

Found only on Monos Island.

78. **Myiozetetes sulphureus** (*Spix*).

One of two specimens seen at La Brea was taken.

79. **Rhynchocyclus flaviventris** (*Wied*). — BROAD-BILL. GOBE-MOUCHE À DOS VERT.

Platyrhynchus flaviventris LÉOTAUD, p. 247.

A common inhabitant of the forests and second-growths, where it frequents the lower trees. Its note is a loud, high *s-e-e-e-e-p*.

80. **Rhynchocyclus sulphurescens** (*Spix*).—BROAD-BILL. TILLON À LARGE BEC.

Platyrhynchus æquinoctialis LÉOTAUD, p. 245.

Not uncommon in the forests.

A nest of this species, found April 17, is a remarkable structure. It is composed of leaf-stems, vegetable fibres and black rootlets woven firmly together, and was hung from near the end of a slender branch about fifteen feet from the ground. It is twelve inches in length and five in width at its widest part. The outline of one side is nearly straight, of the other convex. The curve of this side meets an imaginary perpendicular line drawn from the upper to the lower end of the nest, two inches from the lower end, and is then continued in a line parallel to the other side, but three inches from it. The lower end, therefore, forms a neck two inches in length and two in internal diameter, which constitutes the entrance to the nest, while the nest itself is placed in the convexity of the curved side. The plan of the structure is therefore similar to that seen in the nests of some Weaver-birds, but is, as far as I know, unique among the Flycatchers. Its object is obviously protection from the attacks of tree-snakes and nest-robbing opossums.

When found it was not quite completed, and both birds were present, though only one seemed to be at work. They entered the tubular mouth of the nest in full flight, but with such unerring aim that their passage caused the structure to sway but slightly.

81. Pitangus sulphuratus (*L.*) — QU'EST-CE-QU'IL-DIT À BEC ÉTROIT.

Pitangus rufipennis TAYLOR, p. 86.
Saurophagus sulphuratus LÉOTAUD, p. 210.

This species is one of the commonest and most generally distributed birds of Trinidad. It is a very noisy bird, and its rather harsh call, from which it receives its local name, with other rolling, chattering notes, are among the most characteristic sounds of the Trinidad bird-world. It is one of the first birds to call in the morning and the last to be heard at night. The notes of the first caller are the signal for a chorus of *Qu'est-ce-qu'il dits*, which echo from every side. Their favorite haunts are the more open growths or partial clearings, and they are always to be found in the cacao groves. Here they place their nests in the main crotch of the immortel trees at a distance of about twenty feet from the ground. The nesting season is evidently a long one. On my arrival I found completed nests, and new ones were being made at the time of my departure. They are large structures, composed of fine, dry grasses rather loosely put together, and are arched over, the entrance being on one side. Both sexes work in their construction, and I have seen one bring material to its mate who was on the nest adjusting it.

Three specimens of this bird are clearly referable to *Pitangus sulphuratus* rather than to *P. derbianus rufipennis.* The tail feathers have only a very slight margin of rufous on their outer webs, while on the primaries this color does not reach to the vane of the feather. These parts are therefore less marked with rufous than in the northern *P. derbianus*. It is obvious then that the birds cannot be referred to *P. d. rufipennis*, in which the rufous markings reach the maximum. For comparison with the Trinidad specimens I have had numerous examples of *derbianus* from Mexico, one of *P. d. rufipennis* from Bogota, and two from Santa Martha, while of *P. sulphuratus* I have one specimen from each of the following localities: El Pilar, Venezuela; the Essequibo River; and Cayenne (the type locality).

82. **Myiodynastes audax** (*Gm.*).—PIPIRI.

TAYLOR, p. 86.
Myiobius audax LÉOTAUD, p. 219.

Not uncommon in pairs in the forests. Its note is a harsh chatter.

83. **Megarhynchus pitangua** (*L.*).—QU'EST-CE-QU'IL-DIT À BEC LARGE.

TAYLOR, p. 86.
Megarhynchus chrysogaster LÉOTAUD, p. 208.

Apparently not common. Its notes are a hoarse, chattering whistle, easily recognizable from those of *Pitangus sulphuratus.*

84. **Myiobius nævius** (*Bodd.*).—YELLOW-CRESTED PETCHARY. GOBE-MOUCHE À HUPPE JAUNE.

Myiobius crysoceps LÉOTAUD, p. 222.

Not uncommon. Unlike other Flycatchers it did not frequent the forests or second-growths, but preferred brush-lots or grass-grown fields, choosing much the same locations in fact as *Synallaxis* lived in. The nature of its haunts suggests protective coloration, as the explanation of this bird's rather unusual color. The brown of its upper surface rendered it much less conspicuous than the green color of the tree-haunting Flycatchers would have done. It generally perched near the ground and remained quiet for many minutes, while uttering its simple, rolling, twittering notes.

85. **Empidochanes cabanisi** (*Léotaud*). — LÉOTAUD'S PETCHARY.

Empidonax cabanisi LÉOTAUD, p. 232; SCLATER, Ibis, 1867, p. 108.
Ochthæca arenacea SCL. & SALV. P. Z. S 1877, p. 20.
Empidochanes arenaceus SCL. Cat. Bds. Brit. Mus. XIV, 1888, p. 217.

I found this species only on Monos Island, where it is not uncommon.

An examination of Léotaud's specimens shows that his *Empidonax cabanisi* is the same as Sclater and Salvin's *Empidochanes arenaceus*, and as Léotaud's name has ten years' priority, it must replace the one subsequently given.

An *Empidochanes* from Tobago in the American Museum Collection is apparently so distinct from the Trinidad species that I have no hesitation in describing it as

86. Empidochanes cabanisi canescens, subsp. nov.

Char. sp.—Similar to *E. cabanisi*, but upperparts grayish brown without any tinge of greenish or yellowish; wing-coverts much paler, and underparts with scarcely a trace of yellowish.

Description of Type (Coll. Am. Mus. No. 42,760 *bis*, male, Tobago, May; Ober).—Upperparts dull grayish brown, becoming browner on the rump; tail of nearly the same color as the back, the outer webs of the feathers with slight brownish margins; wings somewhat darker than the tail, the outer edge of the first primary and of the secondaries margined with sandy grayish, the lesser and greater coverts tipped with pale isabelline; a white superciliary line; auriculars grayish; throat dirty white, breast grayish; belly white, with an almost imperceptible yellowish suffusion; flanks grayish.

For comparison with the type I have two specimens of *cabanisi* from Trinidad, and one from Venezuela. The Venezuelan specimen is practically identical with those from Trinidad.

87. Empidonax lawrencei *Allen*.—GREENISH-BELLIED PETCHARY. GOBE-MOUCHE À POITRINE VERDÂTRE.

ALLEN, Bull. Am. Mus. Nat. Hist. II, 1889, p. 150.
Myiobius flaviventris LÉOTAUD, p. 229.
Octhœca flaviventris LAWR. Ann. N. Y. Acad. Sci. IV, 1887, p. 60.

Not uncommon, but confined exclusively to the forests. Its note is described in my journal as *pee*, *ee-dee*, *dee-dee-dee*, given with a kind of *purling* sound.

Comparison with the unique type of *E. lawrencei* shows that my specimens should be referred to that species, the habitat of which has been before unknown. The relationships of this bird have been discussed by Dr. Allen (l. c.).

88. Contopus brachytarsus (*Scl.*).—BUFF-BELLIED PETCHARY. GOBE-MOUCHE À VENTRE JAUNÂTRE.

Contopus bogotensis TAYLOR, p. 87.
Myiobius virens LÉOTAUD, p. 226.

A common species, particularly interesting to me because of its resemblance in coloration to our *C. virens.* This resemblance is so close that Dr. Sclater remarks: "In some cases it is difficult to discriminate between this species and dwarfed or immature examples of *C. virens.*" In life, however, the two species would never be confounded. *C. virens*, as is well known, is a bird which frequents higher trees of the woods, where its musical *pee-a-wee* is a characteristic sound. *C. brachytarsus*, on the other hand, was not found in the forests, but favored more open growths, cacao groves being favorite resorts. Here it perched near the ground. I rarely saw it higher than twenty feet, while its call is an unmusical, low rolling twitter.

On April 14 a pair were seen building a nest on a *bois immortel*, about twenty feet from the ground.

89. Myiarchus tuberculifer (*d'Orb. & Lafr.*).—FOOLISH PETCHARY. GOBE-MOUCHE BRUN.

Tyrannus tuberculifer D'ORB. & LAFR. Syn. Av. I, p. 43.
Myiarchus tuberculifer BERL. Ibis, 1883, p. 141.
Myiobius stolidus LÉOTAUD, p. 221.
Myiarchus tricolor PELZ. Orn. Bras. 1869, p. 182.
Myiarchus gracilirostris, *ibid.* p. 183.
Myiarchus coalei RIDGW. Proc. U. S. N. M. IX, 1886, p. 521 (type examined).
Myiarchus nigriceps SCL. Cat. Bds. Brit. Mus. XIV, 1888, p. 258 (in part).

A laying female taken April 24 was the only one observed.

Comparison shows this specimen to be the same as *Myiarchus coalei*, the type of which Mr. Ridgway has kindly loaned me. Both birds agree with a *Myiarchus* collected by Goering at Merida, Venezuela, and labeled by Count von Berlepsch "*Myiarchus tuberculifer* Lafr. & d'Orb." The same ornithologist has examined the type of *coalei*, and on the back of the label I find the pencilled identification, "=*Myiarchus tuberculifer* Lafr. & d'Orb."

Dr. Sclater (Cat. Bds. Brit. Mus., XIV, p. 259), who has examined d'Orbigny's specimens of *tuberculifer* in the Paris Museum, considers them to belong to either *Myiarchus atriceps* or *M. tricolor.*

In size, however, judging from d'Orbigny's description, they would seem to agree more closely with the latter.

Count von Berlepsch has examined Von Pelzen's types of *M. tricolor* and *M. gracilirostris*, and concludes that both are identical with *tuberculifer* of d'Orbigny, a name which he would apply to the birds with a sooty-black or brownish cap, "found in New Granada, Venezuela, [Trinidad], Guiana, Eastern Ecuador, Brazil, and Bolivia," restricting the name *nigriceps* of Sclater to the *black*-capped birds of Western Ecuador, Peru, and, I may add, Panama. Comparisons of specimens from Panama (Galbraith) and Quito with those from Venezuela and Trinidad convince me of the correctness of Count von Berlepsch's determinations.

90. **Myiarchus tyrannulus** (*Müll.*).—BLACK-BILLED PETCHARY. OISEAU FOU.

Myiarchus ferox TAYLOR, p. 87.
Myiobius nigriceps LÉOTAUD, p. 231.

Rare at the rest-house, where I observed it on only two occasions, but common on Monos. Its song is markedly different from that of *M. crinitus*.

91. **Tyrannus melancholicus satrapa** (*Licht.*).—QU'EST-CE-QU'IL-DIT À TÊTE GRISE.

Tyrannus melancholicus TAYLOR, p. 87; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Tyrannus verticalis et *T. vociferans* LÉOTAUD, p. 213.

Common; frequenting clearings and the more open growth. Its favorite perch was on the wires of a telegraph line which ran through the forest to Moruga, and it seemed to be the only species which regularly used them. Its call is a long, twittering, Kingbird-like roll.

Dr. Allen has recently discussed the relationships of this bird (Bull. Am. Mus. Nat. Hist., IV, 1892, p. 349).

92. **Tyrannus rostratus** *Scl.* — QU'EST-CE-QU'IL-DIT À VENTRE BLANC.

TAYLOR, p. 87.
Tyrannus magnirostris LÉOTAUD, p. 215.

93. **Milvulus tyrannus** (*L.*). — SWALLOW-TAILED FLYCATCHER. LONGUE-QUEUE.

LÉOTAUD, p. 217.

Family PIPRIDÆ.—MANAKINS.

94. Pipra aurocapilla (*Licht.*).—MANAKIN À TÊTE D'OR.

TAYLOR, p. 87.
Pipra erythrocephala LÉOTAUD, p. 255.

This beautiful little bird is not uncommon, and a few were observed nearly every day. They were generally found on a low tree bearing small berries, which grew at the border of the forest just back of the rest-house. They took these berries as Trogons do, by flying at them and picking them off while on the wing. They also feed on insects, which they capture after the manner of Flycatchers. One male passed the entire day among the rafters at the rest-house. He seemed perfectly at home, and flitted from one perch to another while in pursuit of the insects gathered there.

Their note is a short, sharp twitter, not frequently uttered.

95. Manacus manacus (*L.*).—WASHERWOMAN. CASSE-NOISETTE.

Chiromachæris manacus TAYLOR, p. 87.
Pipra gutturalis LÉOTAUD, p. 253.

A not uncommon species. They were generally found in and at the borders of the forests, where they haunt the lower growth of bushes. They were frequently found in small companies of four to six individuals. Their chief food seemed to be small berries, which they picked while on the wing, thus resembling *Pipra aurocapilla* in feeding habits.

This bird possesses unique gifts as a musician. It produces no less than four different sounds in as many different ways. The first is vocal, and consists of a short, sharp twitter, very much like that uttered by *P. aurocapilla*. The second is presumably made by snapping the mandibles together. It can be closely imitated by quickly breaking a dry twig about the size of a lead-pencil. This is heard only when the bird is on the wing. The remaining two sounds are produced by the wing-quills. I find them described in my journal as follows: "The presence of *Manacus* is as frequently announced by the bird's whirring, buzzing flight as by a sight of the bird itself. This sound, which can be easily heard at a distance of fifty feet, seems to accompany even the shortest flight.... The whirring is apparently occasioned by the four outer attenuate primaries, as in other birds having feathers of this description. The buzzing, however, appears to be produced in an entirely different manner. The same sound can be made by simply opening and closing the wing of a freshly-killed bird. This action causes the edge of the wide, stiffened outer margins of each secondary to rub over the inner margin of the feather next to it. The result is a slight grating sound of the same character, but of course lower in tone than the buzzing produced by the bird in flying."

I afterwards held wounded birds by the bill, and in fluttering their wings they made both the whirring and the buzzing sounds.

Being thus so singularly gifted, *Manacus*, as might be expected, proved an exceedingly interesting bird. I regret that I could not determine the significance of the snapping sound, which is apparently reserved for special occasions. I heard it only when a number of the birds were together, when, evidently animated by the same motive, they hopped and flitted about in the undergrowth.

Such a scene is described in my journal under date of April 5: "An interesting bit of bird-life had for its actors four Manakins (*Manacus*). Three were in adult male plumage, the fourth was in female plumage, but, to my surprise, proved on dissection to be an immature male. The birds were in the lower bushes at the edge of the forest. They were all uttering, in an excited way, their sharp, twittering call, at the same time they were jumping back and forth from bush to bush, buzzing and whirring at every wing-stroke, and frequently, with each jump, making the sharp snapping sound. Sometimes two birds would engage in what seemed a desperate combat; at others, the activity of all would reach a maximum, and the result was the strangest chorus of bird 'music' I have ever heard."

Family COTINGIDÆ.—Cotingas.

96. **Tityra cayana** (*L.*).—Blackcap. Bénédictin.

Léotaud, p. 239.

Not common. I found it only in the forests, where it frequented trees bearing fruit, on which it fed. The only note I heard was a loud, reedy *cack*, not unlike that which can be produced with a duck-call.

97. **Pachyrhamphus albogriseus** *Scl.*

TAYLOR, p. 87.

98. **Pachyrhamphus niger** *Spix.* — BLACK HARDBEAK. BECDU.

TAYLOR, p. 87.
Tityra nigra LÉOTAUD, p. 241.

Not common. It seemed to favor second-growths.

99. **Chasmorhynchus variegatus** (*Gm.*).— BELL-BIRD. CONG. CAPUCIN. CAMPANERO.

Chasmorhynchus niveus TAYLOR, p. 88.
Chasmorhynchus variegatus SCL. Ibis, 1866, p. 407; *ibid.* 1867, p. 108.
Procnias variegata LÉOTAUD, p. 259.
Procnias nivea LÉOTAUD, p. 261.

As Dr. Sclater remarks, there is doubtless but one species of Bell-bird in Trinidad. Mr. Taylor's record was not based on specimens of *niveus*, nor are there specimens of this species in the Léotaud Collection.

From many sources I was told that the Campanero was frequently heard in the Moruga forests. I made several trips to localities said to be favored by it, but was not fortunate enough to meet with one.

Family DENDROCOLAPTIDÆ.—WOOD-CREEPERS, OVENBIRDS, ETC.

100. **Sclerurus albigularis** *Swains.*

On three occasions I met with single individuals of this bird. They were on the ground in the forest, and uttered sharp, metallic notes of alarm.

101. **Synallaxis cinnamomea** (*Gm.*).—GUIOUTI DES JONCS.

Synallaxis ruficauda LÉOTAUD, p. 155.

This species was met with only at the mouth of the Cipero River.

102. Synallaxis albescens *Temm.* Guiouti.

Synallaxis ruficapilla Léotaud, p. 153.

A not uncommon species in the tall grasses of some uncultivated cacao groves or clearings. It clings to the grass stalks in a manner which reminds one of a Marsh Wren. Its song, which is uttered with great persistency, consists of two wheezy notes twice repeated, thus: *wĕr-chee, wĕr-chee.* On being alarmed it has a sharp rolling twitter.

The immature bird of this species differs from the adult in lacking the rufous cap and wing-coverts, and in being washed with brownish below.

103. Synallaxis terrestris *Jard.*—Guiouti à gorge ginga.

Synallaxis cinerascens Léotaud, p. 152.

104. Xenops rutilus *Licht.*—Petit Grimpeur.

Taylor, p. 85; Léotaud, p. 156.

105. Dendrocincla merula meruloides (*Lafr.*).—Little Cacao Insect-pecker. Petit Mangeur de cacao.

Dendrocops meruloides Léotaud, p. 167.

A common species in the forests and cacao groves, where it resembles a Creeper in habits. It is apparently a very silent bird; the only notes I heard from it were a low *chŭh, chŭh.*

106. Dendrocolaptes altirostris *Léotaud.*—Charpentier à bec courbe.

Léotaud, p. 166.

The type of this species, according to Léotaud, was submitted to Lafresnaye, who considered it a valid species. It is not now represented in the Léotaud Collection.

107. Dendrornis susurrans (*Jard.*).— Cacao Insect-pecker. Mangeur de cacao.

Taylor, p. 85.
Nasica sussurans Léotaud, p. 160.

Common. It frequents the forests and cacao groves, and is generally seen in pairs. It secures its food not by drilling, as do Woodpeckers, but from crevices in the bark, etc., as do the true Creepers (*Certhia*). The usual call of this species is a short *kēē-*

you, so exactly like the call of a High-hole (*Colaptes auratus*) that were the two birds calling it together it would not be possible to distinguish them by their notes. In addition to this call it has a loud, musical piping whistle, composed of quarter notes. This greatly resembles the call of *Galbula*, but is louder.

My series is very uniform in coloration, and, beyond a slight difference in intensity of coloration, presents little variation.

108. Dendroplex picus (*Gm.*).—MANGROVE PECKER. CHARPENTIER DES MANGLES.

Dendrocolates picus LÉOTAUD, p. 164.

109. Picolaptes albolineatus (*Lafr.*). — CHARPENTIER RAYÉ.

Picolaptes lineaticeps LÉOTAUD, p. 158.

Observed on only two occasions.

Family FORMICARIIDÆ.—ANT-BIRDS.

110. Thamnophilus major *Vieill.*—COUCOU.

TAYLOR, p. 85.
Thamnophilus stagurus LÉOTAUD, p. 266.

A common species, living in the lower growth in and at the borders of the forest. My experience with it may be given by several quotations from my journal:

"March 15.—I identified this evening the call of *Thamnophilus major*. The bird was thirty feet from the ground in a tree in the forest. Its low call commenced very slowly and deliberately, *chŭh—chŭh—chŭh*, getting faster and faster, until one could not distinguish the syllables, and ending quite unexpectedly in a long, drawn out *chāār*, so unlike the preceding notes, I could not believe, at first, that they were uttered by the same bird."

A bird seen on April 6 seemed by its actions to explain the use of the concealed white dorsal patch of this species. To quote again from my journal: "Two males were wooing a female. She remained in the undergrowth, while, most of the time, they were in the lower trees above her. Her preference I had no means of knowing, but certainly there was no question as to which was the most valorous of the males. One was a cringing, cowardly fellow who made no attempt at display, and uttered a whining note as the other chased him about. The other was a most gallant wooer. After a vigorous rush at his ever-fleeing rival he would pose, presumably for the benefit of the modest brown bird below him. Throwing out his breast, he raised his head until the bill pointed slightly backwards, and remained this way for several seconds. It was a position typical of the vaunting, defiant conqueror. His crest was raised, his red eye glared, and in the centre of the back was a distinct white line, which at times increased to a large round spot. This was visible both when he was at rest and on the wing, and was evidently displayed as an adornment. In the other male it was not visible."

111. Thamnophilus doliatus (*L.*).—PINTADE.

TAYLOR, p. 85; LÉOTAUD, p. 264.

A very common bird at the borders of the forests and in thickets of second-growth, beyond which, except for occasional visits to neighboring cacao groves, it was never seen. The calls of both sexes are alike. Their common note is a long-drawn rolling call, resembling in character, but easily distinguishable from, that of *T. major*. It is not concluded by the singular *chāār* of *major*, but *doliatus* has a somewhat similar note which it utters without reference to its regular call. This is a hoarse *cāār*, and might be mistaken for the *caw* of a Fish Crow. At times it utters also low croaks.

112. Thamnophilus cirrhatus (*Gm.*).—CHARBONNIER.

Thamnophilus atricapillus TAYLOR, p. 85; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Formicarius cirrhatus LÉOTAUD, p. 195.

This bird was found more or less commonly at all points on the coast which I visited, but was not seen in the interior.

It resembles *T. doliatus* in habits, and the only call I heard was not unlike the rolling call of that species.

113. Dysithamnus mentalis spodionotus (*Salv. & Godm.*).

This bird was found in small companies of not more than six individuals in the lower trees in the forests. They were generally associated with *Myrmotherula axillaris*. Their call, of three or four low, sweet notes, is given by both sexes. It is Thrush-like in tone, and resembles the soft, querulous alarm notes of a Robin (*Merula migratoria*).

Adult males agree with the description of this race in being nearly concolor above, and in having the underparts without an olivaceous wash.

114. Myrmotherula axillaris (*Vieill.*).—Petit Charbonnier.

Taylor, p. 85.
Formicarius axillaris Léotaud, p. 194.

Found in the forests, where, in company with *Dysithamnus*, it frequented the lower trees. The only note I identified was a low *cack*.

115. Formicivora intermedia *Cab.*

Taylor, p. 85.

116. Myrmeciza longipes[1] albiventris *Chapm.*—Petit Fourmilier.

Myrmeciza longipes albiventris Chapm. Auk, X, 1893, p. 342 (preliminary descr.).
Formicarius longipes Léotaud, p. 191.

Char. subsp.—Similar to *Myrmeciza longipes* (Swains.), but somewhat smaller, and with the flanks and abdomen but slightly or not at all washed with cinereous.

Description of Type (No. 59,329, Coll. Am. Mus. Nat. Hist., adult male, Princestown, Trinidad, March 10, 1893; Frank M. Chapman).—Back and exposed surface of the wings rufous brown, tail slightly darker, crown and hind-neck darker than the tail, bordered laterally and anteriorly by cinereous; throat, breast, cheeks and ear-coverts black; sides of the breast with a slight cinereous wash; abdomen white, sharply defined from the black breast; sides washed with fulvous brown, heavier on the flanks and crissum; feet and legs flesh color, bill black; anterior parts of the skin of the head and throat in life deep, dull blue. Female similar to the female of *longipes*.

[1] The continental form of this bird has long been known as *Myrmeciza longipes* (Vieill.) Count von Berlepsch has shown, however, that Vieillot's description undoubtedly does not apply to this bird, and he has therefore renamed it *Myrmeciza swainsoni* Berl. In doing this, Count von Berlepsch considers that the *Drymophila longipes* of Swainson, while answering exactly to the *Myrmeciza longipes* of authors, is a synonym of the unrecognizable *Mymothera longipes* of Vieillot. I cannot agree with this decision, and prefer to accept Swainson's name, the synonymy of which will stand as follows:

Myrmeciza longipes (*Swains.*).

Drymophila longipes Swains. Zool. Journ. 1824, II, p. 152 (not *Mymothera longipes* Vieill. Nouv. Dict. XII, 1817, p. 113).
Myrmeciza longipes of most authors.
Myrmeciza swainsoni Berl. Ibis, 1888, p. 130; Salv. & Godm. Biol. Cent. Am. II, p. 229.

Ten males from Trinidad compared with two from Panama and one from Carthagena show that while the characters on which this new form is based are slight, they are constant and easily recognizable.

This is a very common species in the vicinity of the rest-house. It is found in pairs in the second-growth, and also in the dense undergrowth at the borders of the woods, but I never saw it in the depths of the forest. It passes most of the time on the ground, gleaning among the leaves, with which it harmonizes so exactly in color that unless its breast is turned toward one it is exceedingly difficult to distinguish the bird from its surroundings. They are unsuspicious birds, and by using a little caution one can approach to within a few feet of them. The call of the male is a loud, ringing whistle. The first note is the highest and loudest; the call then descends, and at the same time decreases in volume and rapidity. It has all the *suddenness* of the calls of some Rails, and when heard at short range is a startling performance. The female, as far as I could learn, does not utter this call, but at its conclusion she frequently adds an appreciative twitter. Although so much of a ground bird, this species does not walk but hops.

117. Rhamphocœnus melanurus trinitatis (*Less.*).—Echelette.

Rhamphocœnus trinitatis Lesson, Rev. Zool. 1839, p. 42.
Rhamphocœnus melanurus Léotaud, p. 168.

A not uncommon bird, frequenting in pairs low second-growth or the smaller trees at the border of the forest. It is a nervous, active little bird, constantly on the move, and its long tail is twitched about with all the energy of a Wren. Its call is a monotonous, high, rattling, metallic trill.

The Trinidad bird is well deserving of recognition as a race. It resembles *melanurus* in the coloration of the underparts, but has the head, nape, cheeks and sides of the neck rufous brown, as in *R. rufiventris*.

118. Heterocnemis nævia (*Gm.*).—Bécassine à rivière.

Formicarius lineatus Léotaud, p. 192.

At the rest-house this species was rather rare, and was found only near brooks in the forest. On the banks of the Moruga and Caroni Rivers they were apparently common in the mangroves. As far as my experience goes they are shy, active, nervous birds, reminding me in their movements of a Water Thrush and the Carolina Wren. They feed on the shore of the brooks or from projecting roots, twitching out water-soaked leaves with a flirt of the bill. Their notes are sharp and metallic, resembling somewhat those of *Sclerurus*, or, when joined in a long rattling call, they suggest a similar performance by the Carolina Wren.

119. **Formicarius analis saturatus** (*Ridgw.*). — COQ-BOIS.

Formicarius saturatus RIDGW. Proc. U. S. N. M. XVI, 1893, p. 677.
Formicarius hoffmanni LÉOTAUD, p. 187.

This species is found only in the forests, where it is not uncommon, but is much more frequently heard than seen. Its usual call consists of four loud, clear, flute-like whistles; the first is the highest and longest, the last three are about one-third the length of the first. Occasionally the concluding notes are repeated many times, and are then given more rapidly. When heard in the depths of the dark, silent forest the musical notes of this bird are sure to command the attention of the most unobservant. The bird readily responds to even a poor imitation of its call, and walks rapidly towards the point at which its supposed friend or foe is stationed. I was struck not alone by the promptness with which they replied, but by the ease with which they located the position of the caller. On one occasion, while watching for Agoutis from a hunter's perch in the forest, I answered a Coq-bois which was whistling not nearer to me than seventy-five yards. I called only once, but in a few minutes the bird came directly to me, and, pausing almost beneath my perch, called frequently, at the same time looking anxiously from side to side. After circling about for several minutes it started to return by the same route it had come, but on my whistling it at once came back to me.

The Coq-bois is preëminently a ground bird. It is difficult to make it fly, and it takes wing only as a last resort. Its flight is then short, and resembles somewhat that of a Sora Rail (*Porzana carolina*). It walks quickly and gracefully over the fallen leaves, sometimes mounting fallen logs, but never, so far as I observed, perching in the branches of bushes or trees. When walking, and even when feeding, the tail is carried erect at right angles to the back, and the reddish brown crissum is then a conspicuous character.

Order MACROCHIRES.

Hummingbirds, Swifts, Goatsuckers, etc.

Family TROCHILIDÆ.—HUMMINGBIRDS.

120. **Glaucis hirsutus** (*Gm.*). — BROWNBREAST. COLIBRI BALISIER.

Glaucis mazeppa TAYLOR, p. 90.
Polytmus hirsutus LÉOTAUD, p. 139.

One of the most common species of Hummingbirds. They frequented only the lower-growth, and I do not remember ever having seen one more than fifteen feet from the ground. Their favorite resort was among the luxuriant 'wild bananas' (*Heliconia*), in or at the borders of the forests, from the flowers of which they obtained a large part of their food.

These flowers average one and one-half inches in length, are slightly curved in shape, and have the petals tightly wrapped together about the pistils. They stand upright in rows in the conspicuous *Heliconia* cups. In probing them the Hummingbirds insert their bill by a downward thrust, made from a position above the flower, and then let their body fall to a level below that of the top of the flower. They are enabled to assume this position through the curved shape of their bill, which corresponds exactly to the curve of the flower. This method of feeding is so marked a characteristic of this species, as I observed it, that it seems not improbable that the habit has resulted in modifying the shape of the bird's bill. At times they alight on the edge of the cup, and probe the flower more at leisure.

They also feed on insects taken from the under sides of leaves. These were captured with the tongue, which is capable of being extended an inch beyond the tip of the mandibles.

On rare occasions I heard this species sing a weak song.

121. Pygmornis longuemareus (*Less.*).—Colibri à raquette. Ratchette.

Taylor, p. 91; Léotaud, p. 128.

Found in about the same numbers as *Glaucis hirsutus*, which it closely resembles in distribution and habits.

This species has a song of decided character. The circumstances under which I first heard it may best be described by a quotation from my journal under date of March 2: "As I entered a growth of low 'roseau' palms I was attracted by a chorus of squeaky voices, which at first I attributed to *Arbelorhina*. They seemed to be near the ground and very close to me, but, look as carefully as I would, I could see neither birds nor moving leaves. Finally, after several minutes, I espied a tiny Hummingbird perched on a twig about ten feet from me, and one foot from the ground. He was quivering with song. His bill was upraised, and his body trembled with the violence of his vocal effort. It was not much of a song, as songs go, but for a Hummingbird it was a remarkable performance. It consisted of seven notes, *swer-e-e-e-e-e-wèr*, the first six the same, the last accented and lower.

Not less interesting than the bird's song was its surroundings. This species is a dull, brownish bird with only a faint greenish tinge on the back, and is thus without the brilliant colors of other Hummers. The space beneath these low palms was partly filled with hanging or fallen dead, brown palm leaves. It was among these *Pygmornis* was perching. It was not too dense to see for a distance of twenty feet in any direction, but so exactly did the bird harmonize with its surroundings in color that even when within a few feet of me it was almost invisible. Their songs came from every side, a chorus of them, but only by the closest scrutiny and with help from my negro guide could I see birds which were singing vigorously and continuously within ten feet of me. Where the palms merged into other undergrowth the Hummers were no longer seen.

Subsequent experiences seemed to show that although the species was generally distributed, this locality was a favorite one for it, and as a rule I always found at least a few birds singing there.

122. **Phaëthornis guyi** (*Less.*).—BRIN-BLANC.

TAYLOR, p. 90; LÉOTAUD, p. 129.

Not common, and always found in the depths of the forest, where it lived near the ground.

123. **Lampornis violicauda** (*Bodd.*).—MANGO HUMMER. PLASTRON.

Lampornis mango TAYLOR, p. 91.
Polytmus mango LÉOTAUD, p. 131.

Observed commonly only while the bois immortel was blooming.

124. **Lampornis gramineus** (*Gm.*).—ROSCAL. HAUSSE-COL. WOSCAL.

TAYLOR, p. 91.
Lampornis dominicus LÉOTAUD, p. 132.

125. **Florisuga mellivora** (*L.*).—JACOBINE.

TAYLOR, p. 91.
Topaza mellivora LÉOTAUD, p. 141.

Very common about the blooming bois immortel, but after they had passed out of blossom it was rarely observed. Its white tail, when the bird was on the wing, was generally spread to the utmost, while the white collar was also frequently displayed.

Two specimens, one nearly adult, the other obviously a bird of the year, have the outer pair of tail-feathers without black tips; the next pair have a black terminal spot on their inner web, and a narrow black margin along the greater part of the outer web; the remaining pairs are broadly tipped with greenish blue, and more or less margined with blackish.

126. **Lophornis ornatus** (*Bodd.*).—WHISKERANDO. COQUETTE. HUPPE-COL.

TAYLOR, p. 91.
Mellisuga ornata LÉOTAUD, p. 148.

127. Calliphlox amethystina (*Gm.*).—AMÉTHIYSTE.

Calothorax enicurus LÉOTAUD, p. 143.

128. Chrysolampis mosquitus (*L.*).—RUBEY AND TOPAZ. RUBIS-TOPAZE.

TAYLOR, p. 92.
Mellisuga moschita LÉOTAUD, p. 145.

A female was secured at the rest-house, and an adult male observed on the Caroni River.

129. Petasophora delphinæ (*Less.*).—BLUE-EARED HUMMER. COLIBRI À OREILLES.

Polytmus delphinæ LÉOTAUD, p. 134.

130. Floricola longirostris (*Vieill.*).—CARMINE. GORGE CARMIN.

Heliomaster longirostris TAYLOR, p. 92.
Mellisuga longirostris LÉOTAUD, p. 147.

131. Agyrtria chionipectus (*Goula*).—WHITE-BREAST. COLIBRI À GORGE BLANCHE.

Thaumantias chionipectus TAYLOR, p. 92.
Polytmus chionopectus LÉOTAUD, p. 140.

Not uncommon. A nest of this species, found March 3, was about twelve feet from the ground, saddled on a small twig near its end. Only one bird, presumably the female, was ever seen near the nest. She apparently began to sit about March 5. I did not learn on what date the one young bird was hatched, but it left the nest April 10.

132. Polytmus thaumatias (*L.*).—PEARL. VERT-PERLÉ.

Chrysobronchus virescens TAYLOR, p. 92.
Polytmus viridis LÉOTAUD, p. 135.

133. Amazilia erythronota (*Less.*).—EMERALD. RAIMÔNDE.

Erythronota antiqua TAYLOR, p. 92.
Polytmus erythronotus LÉOTAUD, p. 137.

Not common.

134. Eucephala cærulea (*Vieill.*).—SAPHIR.

TAYLOR, p. 92.
Hylocharis cœrulea LÉOTAUD, p. 150.

The commonest of the tree-haunting Hummers.

135. Chlorostilbon atala (*Less.*).

TAYLOR, p. 92.

136. Panyptila cayanensis (*Gm.*).—HIRONDELLE À GORGE BLANC.

Cypselus cayennensis LÉOTAUD, p. 81.

Common at La Brea, the only locality at which it was observed.

137. Chætura cinereiventris lawrencei *Ridgw.*—RAIN-BAT. PETITE HIRONDELLE À CROUPION GRIS.

Chœtura lawrencei et *C. cinereiventris lawrencei* RIDGW. Proc. U. S. Nat. Mus. XVI, 1893, p. 43.
Acanthylis oxyura LÉOTAUD, p. 84.

Less common than *Chœtura spinicauda*, with which it was found associated.

138. Chætura spinicauda *Temm.*— RAIN-BAT. HIRONDELLE À CROUPION GRIS.

Acanthylis poliourus LÉOTAUD (in part).

Common in scattered companies of ten to thirty individuals, which night and morning coursed rapidly over the forests and clearings, generally out of gunshot. Their notes resemble in character those of our *Chœtura pelagica*, but they are not so loud and are less frequently uttered.

139. Chætura polioura (*Temm.*).—HIRONDELLE À CROUPION GRIS.

Acanthylis poliourus LÉOTAUD, p. 86 (in part).

I secured one specimen at La Brea.

140. Hemiprocne zonaris (*Shaw*).—RINGED GROWRIE. HIRONDELLE À COLLIER BLANC.

Acanthylis collaris LÉOTAUD, p. 83.

141. Cypeloides rutilus (*Vieill.*).—HIRONDELLE À COLLIER ROUX.

Hirundo rutila LÉOTAUD, p. 87.

There is one specimen in the Léotaud Collection.

142. Chordeiles acutipennis (*Bodd.*).—NIGHTHAWK. ENGOULEVENT À QUEUE FOURCHUE.

Chordeiles minor LÉOTAUD, p. 76.

143. Nyctibius jamaicensis (*Gm.*).—POTOO. GROS ENGOULEVENT.

Nyctibius pectoralis TAYLOR, p. 90.
LÉOTAUD, p. 70.

There is an animal in the Trinidad forests whose call is so inexpressibly sad that it affects even the negroes, and they have given to its author the name of "Poor-me-one," meaning, "poor me, all alone." These words express in a measure the hopeless sorrow of a voice which is so sweet and human in quality that it might easily be considered a woman's rich contralto. This impressive call is heard only at night. At the rest-house I heard it only on moonlight nights, and then at infrequent intervals. It is generally supposed to be uttered by the little Ant-eater (*Cyclothurus didactylus*), which, for this reason, is commonly known as Poor-me-one. I am told, however, by Mr. Albert B. Carr of Trinidad, a gentleman who is very familiar with the animals of the forests, that the Poor-me-one is in reality a Goatsucker, and that he has shot the bird in the act of calling. Unfortunately the bird was not preserved, so for the present its specific identity must remain in doubt. I have placed these remarks under *Nyctibius* for the reason that Waterton's description of the "largest Goatsucker in Demerara" with little doubt refers to what in Trinidad is known as Poor-me-one. Gosse, however (Birds of Jamaica), does not describe this call, and as it does not seem possible that so close an observer could have overlooked it, it is probable Waterton may have erred in his identification.

144. Lurocalis semitorquatus (*Gm.*).—ENGOULEVENT À TACHES ROUSSES.

TAYLOR, p. 90.
Lurocalis gouldii LÉOTAUD, p. 74.

145. Podager nacunda (*Vieill.*).—NACUNDA. ENGOULEVENT À COLLIER BLANC.

Podager nacauda LÉOTAUD, p. 79.

146. Nyctidromus albicollis (*Gm.*).—ENGOULEVENT DES CHEMINS.

Nyctidromus guianensis TAYLOR, p. 90.
Caprimulgus albicollis LÉOTAUD, p. 72.

Common. Its notes resemble those of the Texan *N. a. merrilli*, but are not so loud and lack the bass undertone. They feed at night in the roads and footpaths, and for this reason are called by the natives by a Spanish name meaning Watchman of the Road. This habit causes their notes to be popularly translated as: '*I sèe you, I sèe you*, or, *who arè you, who arè you*,' while a less frequent and very different call is also excellently given as: '*I wòrk, I wòrk, I wòrk—wèll.*'

147. Steatornis caripensis *Humb.*—GUÀCHARO. DIABLOTIN.

TAYLOR, p. 88; LÉOTAUD, p. 65; RIDGW. Proc. U. S. N. M. VII, p. 173; HORNADAY in Standard Nat. Hist. IV, 1885, p. 386.

May 5 I visited the Guàcharo cave on Huevos Island described by Mr. W. T. Hornaday (l. c.), but I can add nothing to his excellent description of it. I estimated the number of birds in this cave at 200, a number which I find corresponds with that given by Mr. Hornaday. A female secured was laying, and my guide, Mr. Morrison, the discoverer of the cave, of whom Kingsley wrote over twenty years ago, was of the opinion that the birds nested more or less every month in the year.

A second cave which I visited is situated on the main island of Trinidad in the first Boca. It contained apparently not more than fifty birds. There is no beach or floor in this cavern; the water reaches to its innermost parts, and as the walls are precipitous I was unable to explore it for nests.

148. Chloronerpes rubiginosus (*Swains.*).—BLUE-HEADED WOODPECKER. CHARPENTIER À TÊTE BLEUE.

TAYLOR, p. 93; LÉOTAUD, p. 339.

Much less common than *Dendrobates kirkii*, which it greatly resembles in habits.

149. Dendrobates kirkii (*Malh.*).—LITTLE RED-HEADED WOODPECKER. PETIT CHARPENTIER À TÊTE ROUGE.

Chloronerpes kirkii LÉOTAUD, p. 341.

Common. Its call, a strong, high, penetrating *chee*, *chee*, *chee*, was heard nearly every day.

150. Celeus elegans (*Müll.*).—Yellow-headed Woodpecker. Charpentier à tête jaune.

Celeus cinnamomeus Taylor, p. 93; Léotaud, p. 338.

151. Campephilus melanoleucus (*Gm.*). — Big Red-headed Woodpecker. Charpentier à tête rouge.

Dryocopus albirostris Léotaud, p. 334.

Three were secured.

152. Ceophlœus lineatus (*L.*).—Black-throated Woodpecker. Charpentier à gorge rayée.

Dryocopus erythrops Taylor, p. 93.
Dryocopus lineatus Léotaud, p. 336.

Not uncommon.

153. Momotus swainsoni *Gray.*—King of the Woods. Houtou.

Taylor, p. 88.
Momotus bahamensis Léotaud, p. 96.

This is apparently an uncommon bird in the vicinity of the rest-house. I observed it on only three occasions, and it was unknown to the natives. One bird, which I watched for some time, made a low, clucking sound, which was accompanied by a quick, but deliberate wagging of the tail from side to side. Occasionally this motion was varied by a rapid, circular sweep, when the pendulum-like wagging was resumed.

154. Ceryle americana (*Gm.*).—Red-bellied Kingfisher. Martin-pêcheur à poitrine rouge.

Léotaud, p. 112.
Chloroceryle americana Taylor, p. 88.

A few pairs were seen on the Caroni, Cipero, and Moruga Rivers, and one pair frequented a small stream in the forest near the rest-house. On one occasion the male of this pair was perched on a stump over the brook, holding in his bill some food. The female came and alighted near him, and he immediately passed the delicacy over to her.

Their call when on the wing is a sharp, rattling twitter, not in the least resembling the call of *C. alcyon.* When they alight this is changed to a rapid, excited *ticking*, like the ticking of a clock which has been disturbed. Gradually this decreases in rapidity and volume, and in less than half a minute ceases.

155. Ceryle superciliosa (*L.*).—LITTLE KINGFISHER. PETIT MARTIN-PÊCHEUR.

LÉOTAUD, p. 114.
Chloroceryle superciliosa TAYLOR, p. 88.

156. Ceryle alcyon (*L.*).—BELTED KINGFISHER. MARTIN-PÊCHEUR À CEINTURE BLEUE.

LÉOTAUD, p. 108.

157. Ceryle amazona (*Lath.*).— AMAZON KINGFISHER. MARTIN-PÊCHEUR À LONG BEC.

LÉOTAUD, p. 111.

158. Ceryle torquata (*L.*).— GREAT KINGFISHER. GROS MARTIN-PÊCHEUR.

LÉOTAUD, p. 106.

159. Trogon collaris *Vieill.*—COLLARED TROGON. COUROUCOU À VENTRE ROUGE.

TAYLOR, p. 88 ; LÉOTAUD, p. 103.

This species was found in the forest six miles south of the rest-house, where I shot one individual and observed another. Its notes were a soft *coo-coo*, like those of *T. viridis*, but they were uttered so slowly my attention was at once attracted by them.

160. Trogon viridis *Linn.*—COUROUCOUAI. GRAND COUROUCOU À VENTRE JAUNE.

TAYLOR, p. 88 ; LÉOTAUD, p. 98.

Common. It frequents the denser parts of the forest, and rarely, if ever, makes extended flights. I have seen them, however, cross a small clearing, when their flight was strong and undulating, like that of a Goldfinch (*Spinus tristis*). The call of both sexes is alike, and consists of a melancholy *coo, coo*, repeated rather slowly many times. They feed on fruit, which they pick on the wing. Perching near a tree bearing their food, they make dashes at it, and then, like a Flycatcher, return to their perch to swallow it. From an experience with a wounded bird, I should judge that the sharp serrations on both mandibles are of great assistance to Trogons in this mode of procuring food.

161. Trogon meridionalis SWAINS.—LITTLE YELLOW-BELLIED TROGON. PETIT COUROUCOU À VENTRE JAUNE.

Trogon sulphureus LÉOTAUD, p. 101.

Quite as common as *T. viridis*, with which it was associated. Its notes are similar in tone to those of *T. viridis*, but are uttered more rapidly, and almost exactly resemble the long, rolling call of our High-hole (*Colaptes auratus*).

162. Galbula ruficauda *Cuv.*—JACAMAR.

TAYLOR, p. 88; LÉOTAUD, p. 116.

A not uncommon bird at the borders of and in the forests. Its appearance, at first sight, would seem to support its reputation for stupidity, but closer observation will, I think, induce one to believe that these birds are by no means so stupid as they have been said to be.

They are the most expert 'Flycatchers' I have ever seen, and this, in spite of the fact that the shape of their bill would seem better to fit them for almost any other mode of existence. Sitting all *drawn in* on a dead limb, generally near the ground, they may be compared to a set spring. Their watchfulness permits no insect to pass in safety. They maintain a constant lookout, turning the head quickly from side to side, above, or even half-way around. The dart into the air is made with wonderful celerity. Sometimes it is straight up, again at various angles, and they go as far as thirty to thirty-five feet from their perch. As a rule they return to the same perch after each sally, and may occupy this for many minutes.

As they rest they utter a singular call—a loud, clear, piping whistle, not unlike the call of a lost duckling. This is delivered in a variety of ways. Sometimes it is given as a single whole note, when it may be repeated at intervals of a second for minutes at a time. The dart into the air for an insect interrupts this musical reverie only momentarily, and, on returning to their perch, the plaintive calling is continued. At other times their notes are uttered more rapidly, and may rise into a high, prolonged trilling. This may be *ground out* as revolutions of sound, when the effect is most peculiar.

163. **Crotophaga ani** *Linn.*—TICKBIRD. MERLE CORBEAU.

TAYLOR, p. 92; LÉOTAUD, p. 355.

Common in the cacao groves and second-growth, in flocks of six to twelve individuals. They were nesting in April, but I succeeded in finding only one nest. This was loosely made of sticks placed in the centre of a vine-covered limb, about twenty feet from the ground. It was completed about April 14, but although birds were generally seen at or near it, it was apparently not occupied at the time of my departure.

164. **Crotophaga major** *Gm.*—MARSH TICKBIRD. GROS MERLE CORBEAU.

TAYLOR, p. 93; LÉOTAUD, p. 358.

165. **Diplopteryx nævius** (*L.*).—TRINITÉ. TRINITÉ QUATRE AILES.

TAYLOR, p. 93; LÉOTAUD, p. 343; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.

A common, rather shy bird found in and near thicket-grown clearings. It passes much of its time on the ground, but frequently ascends to the topmost branches of the smaller trees to call. Its calls are also uttered from the ground. They are given more or less throughout the day, and were among the most pleasing and characteristic bird-notes heard near the rest-house. They are of two kinds, and one is heard quite as frequently as the other. Both are in a minor key; the first consists of two notes, the second half a tone lower than the first. The second call is translated by the negroes as *chloë, chloë, chloë-dead, chloë-dead.*

On one occasion, while watching one of these birds *walking* over some recently burned ground, I was surprised to observe a most singular action. The bird walked rapidly for a few yards, then stopping, raised and lowered its crest and turned the black

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feathers of the alula forward until they pointed toward the breast. This was repeated several times, and I find my observation confirmed by Léotaud's account, with which, at the time, I was not familiar.

166. Piaya cayana (*L.*).—Boocootoo. Coucou manioc.

Taylor, p. 93; Léotaud, p. 346.

Not common. I saw about a dozen individuals, which, with one exception, were in the forest. Their flight is weak, and consists of short sails followed by intervals of flapping. The only note I heard was a sharp *chick*.

167. Piaya minuta (*Vieill.*). — Lesser Piaya. Petit Coucou manioc.

Léotaud, p. 348.

Only six individuals were observed. In notes and habits they seemed to resemble the preceding species.

168. Coccyzus melanocoryphus *Vieill.* — Red-bellied Piaya. Coucou manioc à ventre roussâtre.

Piaya melacorypha Léotaud, p. 349.

169. Coccyzus minor (*Gm.*).—Mangrove Cuckoo. Coucou manioc gris.

Léotaud, p. 353.

170. Coccyzus erythrophthalmus (*Wils.*). — Black-billed Cuckoo. Coucou manioc à bec noir.

Léotaud, p. 352.

171. Coccyzus americanus (*L.*). — Yellow-billed Cuckoo. Coucou manioc aux ailes rousses.

Léotaud, p. 350.

A female was taken on Monos, May 4.

172. Ramphastos vitellinus (*Licht.*).—Toucan.

Taylor, p. 93; Léotaud, p. 325.

Common in the forests. Their call, a loud, harsh, double-noted whistle, was one of the characteristic notes heard at the rest-house. When calling the birds perch on the topmost limb of one of the taller forest trees and utter their unmusical notes for many consecutive minutes. Generally two could be heard at the same time. It was not usual to see them make extended flights unless clearings interrupted the continuity of the forests. In crossing these their flight consisted of alternate flapping and sailing. About a dozen rapid strokes were followed by a short, downward sail. They seemed to be shy, silent birds when among the lower branches feeding, and I did not have an opportunity to study their habits. Those seen in the trees were actively hopping from limb to limb, with their tails cocked up forming various angles with their backs, reminding one of gigantic Wrens.

173. Ara makawuanna (*Gm.*).—PETIT ARA VERT.

LÉOTAUD, Appendix, p. 557.

This species is given by Léotaud without remark. I did not meet with Macaws of any species, but received reliable information of the occurrence of some species of Ara, but whether the present or some other I could not determine with certainty.

174. Amazona amazonica (*L.*).—GREEN PARROT. GROS JACQUOT.

Chrysotis, sp? TAYLOR, p. 94.
Psittacus agilis LÉOTAUD, p. 327.

Common, and like most Parrots very restless, spending much time on the wing. Their notes were loud and discordant, and, so far as I learned, consisted of two kinds. One was uttered by a pair of birds when on the wing or, less frequently, when at rest. The other was a far more complicated series of squawks, and was heard only when two or more pairs came together.

A female, shot on March 4, had an egg in her oviduct ready to receive the shell.

175. Pionus menstruus (*L.*) — BLUE-HEADED PARROT. PERRUCHE À TÊTE BLEUE.

Psittacus menstruus LÉOTAUD, p. 329.

Common in pairs or small flocks of four to seven birds. They were generally seen passing over at a considerable height, and attracted attention by their notes.

176. Urochroma cingulata (*Scop.*). — SEVEN-COLORED PAROQUET. PERRUCHE À SEPT COULEURS.

Urochroma melanoptera TAYLOR, p. 94.
Psittacula batavica LÉOTAUD, p. 331.

Common in flocks of from three or four to thirty individuals. Their notes, which consist of a kind of squeaking twitter, were heard only when the birds were on the wing. When at rest or feeding they were silent. It was then exceedingly difficult to distinguish them from the leaves of the tree in which they were perching, and unless a bird moved it was practically invisible. Their favorite food seemed to consist of the fruit of the 'agalee' tree, with the sticky juices of which their bills were generally well covered.

I received from independent sources reliable information that these birds lay their eggs in the nests of the 'white ant,' 'ant-louse,' or termite. These nests are very numerous, and are generally placed thirty or more feet from the ground. They resemble in appearance enormous wasps' nests, and the Paroquets are said to deposit their eggs in holes which they make in the nest for this purpose. At the time of my visit the nesting season was presumably over, for I secured fully grown young of the year.

177. Urochroma hueti (*Temm.*).—RED-WINGED PAROQUET. PERRUCHE AUX AILES ROUGES.

Psittacula hueti LÉOTAUD, p. 332.

178. Strix pratincola *Bp.* — BARN OWL. CHOUETTE BLANCHE.

LÉOTAUD, p. 62.

The sudden, hissing scream of this Owl was occasionally heard at night.

179. Syrnium virgatum *Cass.*—TAWNY OWL. CHAT-HUANT.

LÉOTAUD, p. 60.

An Owl frequently heard calling at night in the forest I imagine from its notes to have been this species, but unfortunately I did not succeed in securing a specimen. Its cry consisted of the four notes, *hōō*, *hōō*, *hōō*, *hŏŏ*, the first three of equal length and on the same note, the last much lower.

180. Megascops brasilianus (*Gm.*). — Eared Owl. Chouette à oreilles.

Ephialtes portoricensis Léotaud, p. 57.

Only one specimen was secured. I did not succeed in identifying the call of this species. An Owl heard nightly in the forest, and said by the natives to be this bird, had a call which may be given as *cook-er-re-coo*, sometimes running off into a series of *coos*. The call bears no resemblance to the trilling notes of our *Megascops*, but apparently is not unlike Hudson's description of that of *Megascops brasiliensis*, as found by him in the Argentine Republic (Arg. Orn., II, p. 51).

181. Pulsatrix torquata (*Daud.*). — Collared Owl. Chouette à collier.

Athene torquata Léotaud, p. 52.

182. Glaucidium phalænoides (*Daud.*). — Petite Chouette.

Glaucidium ferrugineum Taylor, p. 80.
Athene phalænoides Léotaud, p. 54.

An exceedingly common bird; from the rest-house veranda I have heard five calling at the same time. Their usual note is a softly whistled *coo*, resembling in tone that of the Cuban *Glaucidium*, but the last-named bird utters this note about once every five seconds, while in Trinidad these little Owls *coo* four or five times a second. Their call becomes therefore a series of rapidly repeated *coos* continued for fifteen or twenty seconds. At times this runs into a sharply whistled *whoit*, *whoit*, *whoit*, apparently analagous to but not resembling the high piercing notes of the Cuban species. This, as in *G. siju*, is sometimes accompanied by a twitching of the tail. The Trinidad bird, while frequently heard during the day, called in numbers only at night and was thus nocturnal rather than diurnal, contrary to the habit of the Cuban bird.

The negroes consider this species a bird of ill-omen, and translate its rapid cooing as an invitation from the Evil One to "*come, come, come*," etc.

My specimens represent both extremes of the red and gray phases; in the former, with the exception of an indistinct blackish collar on the nape, the head, back and tail are rich reddish brown absolutely without spots or bars; while in the gray phase all the feathers of the head have a terminal and subterminal elongate, whitish spot; there is a nuchal collar; the feathers of the back and rump are more or less spotted with white, and the tail is banded with numerous broken white bars. These extremes are connected by other specimens intermediate both in color and pattern of marking.

183. **Sarcoramphus papa** (*L.*).—KING CORBEAU. ROI DES CORBEAUX

LÉOTAUD, p. 1.
Gyparchus papa TAYLOR, p. 79.

184. **Cathartes aura** (*L.*).—CEDROS CORBEAU. CORBEAU À TÊTE ROUGE.

TAYLOR, p. 78; LÉOTAUD, p. 2.

Common about the rest-house.

185. **Catharista atrata** (*Bartr.*).—TOWN CORBEAU. CORBEAU.

Cathartes atratus TAYLOR, p. 77.
Cathartes fœtens LÉOTAUD, p. 2.

This is the common Buzzard of the towns, and in Port-of-Spain is particularly abundant and tame. When a struggling flock were fighting in the main street over some savory morsel, it was almost necessary to kick them aside when passing through the street. Their usefulness as scavengers is unquestioned, but their habit of perching on the roofs of houses is a serious cause of annoyance to people owning cisterns used for rain-water. Many of them roost in the trees in Marine Square in the city, from which they sail forth on their day's exploring at about four A. M.

186. **Ictinia plumbea** (*Gm.*).—PLUMBEOUS KITE. GABILAN BLEU.

LÉOTAUD, p. 42.

Common, and for a Hawk remarkably tame. Their favorite perch was on the topmost branch of a dead or leafless tree, from which point of vantage they would swoop down on the unwary birds below. Two birds selected perches near the rest-house, where they passed the day maintaining a constant outlook for a possible victim below. At sunset they retreated to the forest to pass the night. This species could always be approached without difficulty, and on two occasions I have had them swoop down to secure a bird which I had shot.

One newly occupied nest was found in March, and another in April. They were small, rather formless structures of sticks, placed in the main crotch of a tree about twenty feet from the ground.

187. **Elanoides forficatus** (*L.*).—SCISSOR-TAILED KITE. QUEUE-EN-CISEAUX.

Nauclerus furcatus LÉOTAUD, p. 30.

Observed on two occasions.

188. **Rostrhamus sociabilis** (*Vieill.*).—HOOK-BILLED KITE. GABILAN À BEC CROCHU.

Rostrhamus hamatus LÉOTAUD, p. 31.

189. **Circus maculosus** (*Vieill.*).—HARRIER. GABILAN À LONGUE QUEUE.

Circus macropterus LÉOTAUD, p. 49.

190. **Buteo abbreviatus** *Cab.*—SMALL BLACK BUZZARD. PETIT GABILAN NOIR.

Buteo zonocercus LÉOTAUD, p. 9.

191. **Urubitinga urubitinga** (*Gm.*).—EAGLE-HAWK. GROS GABILAN NOIR.

Morphnus urubitinga LÉOTAUD, p. 14.

192. **Urubitinga anthracina** (*Licht.*).— BLACK HAWK. GABILAN NOIR.

Astur unicinctus LÉOTAUD, p. 44.

193. **Urubitinga albicollis** (*Lath.*).—GABILAN À DOS NOIR.

Buteo albicollis TAYLOR, p. 79.
Buteo pœcilinotus LÉOTAUD, p. 7.

194. **Asturina nitida** (*Lath.*).—Speckled Hawk. Gabilan ginga.

Taylor, p. 80.
Astur nitidus Léotaud, p. 46.

195. **Harpagus bidentatus** (*Lath.*).—Toothed Falcon. Gabilan à deux dents.

Léotaud, p. 28.

196. **Gampsonyx swainsoni** *Vig.*—Brown Hawk. Gri-gri.

Gampsonix swainsonii Léotaud, p. 41.

197. **Leptodon unicinctus** *Temm.*—Gabilan bleuâtre.

Cymindis unicinctus Léotaud, p. 36.
Cymindis pucherani, *ibid.* p. 40.

198. **Leptodon cayenensis** (*Gm.*).—Guiana Hawk. Gabilan à tête bleue.

Cymindis cayanensis Léotaud, p. 34.

Several were observed and two secured. With the exception of *Ictinia plumbea*, Hawks were not common near the rest-house. I saw probably but two species in addition to those identified.

199. **Spizaëtus mauduyti** (*Daud.*).—Crested Spizaëtus. Gabilan à huppe.

Spizaëtus ornatus Léotaud, p. 10.

200. **Spizaëtus tyrannus** (*Wied*).—Speckled-leg Spizaëtus. Gabilan à pattes ginga.

Spizaëtus braccata Léotaud, p. 12.

201. **Falco peregrinus anatum** (*Bon.*).—Duck Hawk. Gabilan rayé.

Falco peregrinus Taylor, p. 80.
Falco anatum Léotaud, p. 22.

202. **Falco fusco-cærulescens** (*Vieill.*).—Black-bellied Falcon. Gabilan à poitrine noire.

Hypotriorchis femoralis Léotaud, p. 24.

While traveling by rail from Port-of-Spain to Princestown, I looked from the window of the carriage and saw a small *Falco*—

the species I could not determine—flying with the train and about sixty feet above it. For some time it maintained the same relative position, then suddenly, and with great swiftness, darted ahead and was lost to view. A few minutes later I observed a Hawk of the same species occupying the same position above the train as the one which had just disappeared. As I watched it this bird also darted ahead of the train. It was not long before a third Hawk was seen over the train, and, like its two predecessors, it suddenly shot forward. I then began to suspect that the three Hawks were in reality but one, whose object in following the train was to secure the small birds startled from near the track by our approach. The performance was repeated several times, and my surmise in part sustained by seeing the Hawk actually dive into a thicket just ahead of the engine. Indeed, it appeared that the train, like a spaniel, flushed the birds for the Hawk, which was 'waiting-on' overhead.

This explanation is further supported by a notice in the 'Journal' of the Trinidad Field Naturalists' Club (Vol. I, p. 133), where Mr. Caracciolo records the fact of a Hawk seen by Dr. Morton which "pounced upon" small birds frightened from a certain thicket by a passing train. The habit has been observed by Mr. Hudson in the Argentine Republic, where, he states, Duck Hawks follow horsemen in order to secure the small birds flushed from the grass by the horse.

203. Falco deiroleucus *Temm.*—WHITE-THROATED FALCON. GABILAN À TÊTE NOIRE.

LÉOTAUD, p. 17.

204. Falco rufigularis *Daud.*—RED-THROATED FALCON. GABILAN NOIR À GORGE ROUSSE.

Falco aurantius LÉOTAUD, p. 20.

205. Falco columbarius *Linn.*—PIGEON HAWK. GABILAN À DOS BLEUÂTRE.

Hypotriorchis columbarius LÉOTAUD, p. 26.

206. Falco sparverius *Linn.*—SPARROW HAWK.

Tinnunculus sparverius TAYLOR, p. 80.

207. Pandion haliaëtus carolinensis (*Gm.*).—FISH-HAWK. GABILAN PÊCHEUR.

Pandion haliaëtus TAYLOR, p. 79.
Pandion carolinensis LÉOTAUD, p. 15.

208. Columba speciosa *Gm.*—SPECKLED CUSHAT. RAMIER GINGA.

LÉOTAUD, p. 361.
Columba, sp. ? TAYLOR, p. 94.

Not uncommon in the forest in pairs. During the early morning and late afternoon the male perches on the topmost branch of one of the taller trees and utters his loud, deep solemn call. This may be given as *cook-a-loo-coo*, *cook-a-loo*, and is preceded by a low, rumbling note heard only when one is quite near the bird.

209. Columba rufina *Temm.*—BLUE CUSHAT. RAMIER MANGLE.

LÉOTAUD, p. 364.

210. Engyptila rufaxilla (*Rich. & Bern.*).—GROUND DOVE. TOUTERELLE à PAUPIÈRES ROUGES.

Peristera rufaxilla TAYLOR, p. 94; LÉOTAUD, p. 371.

A common bird in the forests and second-growth. It resembles a *Geotrygon* in habits, but is more frequently seen on the wing. Their flight is noiseless, a fact the attenuation of the first primary would not lead one to expect. When on the wing the neck is not extended, but rather drawn in, the bill pointing towards the earth.

The notes of this species formed a background for all other bird music. They resemble the winding notes of a mellow-toned conch. So close is the resemblance that, when in the forest in the early morning, with the soft cooing of these Doves proceeding from all sides, it was not difficult to imagine oneself surrounded by a cordon of conch-blowers. The sound was so continuous that the air vibrated with Doves' notes, and in a short time one became so accustomed to the chorus, that, like the monotonous humming of many insects, it was unnoticed.

A nest found March 10 was a simple platform of sticks placed eight feet from the ground in the main crotch of a small tree at the border of the forest. It contained two young, one of which flew from the nest as I approached.

This species was apparently wanting on Monos Island.

211. **Engyptila verreauxi** (*Bp.*).—GROUND DOVE. TOURTERELLE À PAUPIÈRES BLEUES.

Engyptila verreauxi RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Peristera verreauxi LÉOTAUD, p. 369.

Apparently a rare bird at the rest-house, where I secured only two specimens. On Monos, however, they were very common. Their call is similar to that of *E. rufaxilla*, but not so loud.

212. **Peristera cinerea** (*Temm.*).—BLUE PARTRIDGE DOVE. ORTOLAN BLEU.

LÉOTAUD, p. 378.

213. **Columbigallina rufipennis** (*Bon.*).—RED ORTOLAN. ORTOLAN ROUGE.

Chamæpelia albivitta TAYLOR, p. 95.
Chamæpelia rufipennis LÉOTAUD, p. 366.

Not uncommon in the clearings near the rest-house. Its note is a low, rapid, *put-a-coo*, *put-a-coo*, *put-a-coo.*

214. **Geotrygon linearis** (*Knip & Prév.*).—MOUNTAIN GROUND DOVE. TOURTERELLE À CROISSANT.

Peristera linearis LÉOTAUD, p. 373.

215. **Geotrygon montana** (*L.*).—PARTRIDGE DOVE. PERDRIX.

Peristera montana ? LÉOTAUD, p. 375.

216. **Pipile pipile** (*Jacq.*).—PAOUI.

Crax pipile JACQ. Beytr. zur Gesch. 1784, p. 26.
? Crax alector TAYLOR, p. 95.
Penelope cumanensis LÉOTAUD, p. 383.

I observed only one individual, an adult male, with blue throat and cheeks, shot from a tree in the forest three miles from the rest-house. The flesh of this species is deservedly esteemed, and through the persecution of hunters it is rapidly becoming a rare bird.

Comparison of my one example with specimens of *Pipile cumanensis* from the mainland shows at once well-marked differences. The Trinidad bird is dark brown with deep blue reflections and without the greenish tinge seen in the plumage of true *cumanensis*, while the lengthened feathers of the head are black with a narrow lateral margin of white. In *cumanensis* these feathers are entirely dirty white.

In fact, the Trinidad bird agrees very well with the plate and description of Jacquin's *Crax pipile*, a species which has been synonymized by subsequent writers with the same author's *Crax cumanensis*. There is one specimen of this bird in the Léotaud Collection. It agrees with my example, and is well described by Léotaud.

I could learn nothing of the occurrence of *Crax alector*, a species recorded from Trinidad by Mr. Taylor, who remarks that it is locally called "Wild Turkey." *Pipile pipile* is frequently called by this name. Is it possible that Mr. Taylor has confused the two species?

217. Jacana jacana (*L.*).—SPUR-WING. PAUL PERRUQUIER.

Parra jacana LÉOTAUD, p. 486.

218. Hæmatopus palliatus *Temm.* — OYSTER-CATCHER. HUITRIER.

LÉOTAUD, p. 397.

219. Arenaria interpres (*L.*).—TURNSTONE. PLUVIER DE MER.

Cinclus interpres LÉOTAUD, p. 399.

220. Ægialitis wilsonia (*Ord*). — WILSON'S PLOVER. GROS COLLIER.

Charadrius wilsonius LÉOTAUD, p. 391.

221. Ægialitis semipalmata *Bonap.* — RING-NECKED PLOVER. PETIT COLLIER.

Charadrius semipalmatus LÉOTAUD, p. 392.

Common at Moruga. I saw there also, but unfortunately failed to secure, a small Plover which apparently was *Ægialitis collaris.*

222. **Charadrius dominicus** (*Müll.*).—Golden Plover. Pluvier doré.

Charadrius virginicus Léotaud, p. 394.

223. **Charadrius squatarola** (*L.*).—Black-bellied Plover. Gros Pluvier doré.

Squatarola helvetica Léotaud, p. 389.

224. **Numenius borealis** *Lath.*—Eskimo Curlew. Petit Bec crochu.

Léotaud, p. 444.

225. **Numenius hudsonicus** *Lath.*—Hudsonian Curlew. Bec crochu.

Léotaud, p. 442.

226. **Actitis macularia** (*L.*). — Spotted Sandpiper. Ricuit.

Tringoides macularius Taylor, p. 95.
Tringoides hypoleuca Léotaud, p. 458. (Based on immature specimens.)
Tringoides macularia, *ibid.* p. 461.

Common on the Cipero and at Moruga.

227. **Tryngites subruficollis** (*Vieill.*).—Buff-breasted Sandpiper. Petit Pieds jaunes.

Tringa rufescens Léotaud, p. 470.

228. **Bartramia longicauda** (*Bechst.*). — Bartramian Sandpiper. Pieds jaunes à longue queue.

Tringoides bartramius Léotaud, p. 463.

229. **Symphemia semipalmata** (*Gm.*).—Willet. Ailes blanches.

Totanus semipalmatus Léotaud, p. 456.

230. Totanus solitarius (*Wils.*).—SOLITARY SANDPIPER. GRANDES AILES.

Totanus chloropygius LÉOTAUD, p. 450.

231. Totanus flavipes (*Gm.*).—YELLOW-LEGS. PIEDS JAUNES.

LÉOTAUD, p. 452.

232. Totanus melanoleucus (*Gm.*).—GREATER YELLOW-LEGS. CLIN-CLIN.

LÉOTAUD, p. 454.

233. Limosa hæmastica (*L.*).—HUDSONIAN GODWIT. BÉCARD AILES BLANCHES.

Limosa hudsonica LÉOTAUD, p. 447.
Limosa ægocephala, *ibid.* p. 448.

234. Limosa fedoa (*L.*).—MARBLED GODWIT. GRAND BÉCARD.

LÉOTAUD, p. 445.

235. Calidris arenaria (*L.*).— SANDERLING. BÉCASSE BLANCHE.

LÉOTAUD, p. 480.

236. Ereuentes occidentalis *Lawr.*—WESTERN SANDPIPER. BÉCASSE À LONG BEC.

Heteropoda longirostris et *H. mauri* LÉOTAUD, p. 480.

There are four specimens of this bird in the Léotaud Collection.

237. Ereunetus pusillus (*L.*).—SEMIPALMATED SANDPIPER. BÉCASSE ORDINAIRE.

Heteropoda semipalmata LÉOTAUD, p. 476.

Several were observed, and one taken on the coast of Moruga.

238. Tringa minutilla *Vieill.*—LEAST SANDPIPER. PETIT-MAÎTRE.

LÉOTAUD, p. 476.

Not uncommon on the coast of Moruga.

239. **Tringa fuscicollis** *Vieill.*—WHITE-RUMPED SANDPIPER. GROSSE BÉCASSE.

Tringa melanotus LÉOTAUD, p. 472.

240. **Tringa maculata** *Vieill.* — PECTORAL SANDPIPER. COUCHANTE.

LÉOTAUD, p. 474.

241. **Tringa canutus** *Linn.*—KNOT. POULE COUCHANTE. LÉOTAUD, p. 468.

242. **Micropalama himantopus** (*Bon.*).—STILT SANDPIPER. CHEVALIER.

Hemipalama multistriata LÉOTAUD, p. 466.

243. **Macrorhamphus griseus** (*Gm.*). — DOWITCHER. GRISE À LONG BEC.

LÉOTAUD, p. 482.

244. **Gallinago delicata** (*Ord*).—WILSON'S SNIPE. BÉCASSINE.

Gallinago wilsonii LÉOTAUD, p. 484.

245. **Himantopus nigricollis** (*Müll.*). — BLACK-NECKED STILT. BÉCASSE-LA-MORT.

LÉOTAUD, p. 464.

246. **Heliornis fulica** (*Bodd.*). — SURINAM HELIORNIS. PLONGEON À QUEUE.

LÉOTAUD, p. 531.

247. **Fulica americana** *Gmel.* — AMERICAN COOT. FOULQUE.

LÉOTAUD, p. 504.

248. **Gallinula galeata** (*Licht.*).—RED-SEAL COOT. POULE D'EAU À CACHET ROUGE; COQ-LAGON.

LÉOTAUD, p. 503.

The specimen in the Léotaud Collection has the back without a brownish wash, and of the same color as the wings.

249. Ionornis martinica (*L.*).—BLUE-SEAL COOT. POULE D'EAU À CACHET BLUE.

Porphyrio martinica TAYLOR, p. 96; LÉOTAUD, p. 501.

250. Porzana carolina (*L.*).—SORA. POULE-SAVANNE À GORGE NOIRE.

Ortygometra carolina LÉOTAUD, p. 493.

251. Porzana albicollis (*Vieill.*).—CRAKE. GROSSE POULE-SAVANNE.

SCLATER, P. Z. S. 1868, p. 451.
Crex olivacea TAYLOR, p. 96.
Corethura olivacea LÉOTAUD, p. 499.

252. Porzana cinerea (*Vieill.*).—LITTLE CRAKE. PETITE POULE-SAVANNE.

Porzana cinerea SCL. P. Z. S. 1868, p. 456.
Ortygometra cinerea LÉOTAUD, p. 495.

253. Rallus maculatus (*Bodd.*).—SPOTTED RAIL. POULE D'EAU TACHETÉE.

LÉOTAUD, p. 559.

254. Rallus longirostris (*Bodd.*).—CLAPPER RAIL. POULE D'EAU GINGA.

LÉOTAUD, p. 491.

255. Aramides axillaris *Lawr.* — RED WATER-FOWL. POULE D'EAU ROUGE.

Aramides ruficollis LÉOTAUD, p. 498.

I secured one specimen of this bird feeding in the mangroves which border the Moruga River near its mouth.

256. Aramides cayennensis (*Gm.*). — GREAT WATER-FOWL. GROSSE POULE D'EAU.

Aramides chiricota LÉOTAUD, p. 496.

Apparently a common species in the forests near the rest-house. I did not, however, succeed in seeing it alive, and my four specimens were secured in traps set for small mammals. Its call, upon the identification of which the natives were all agreed, is a remarkable performance. Apparently two birds call together; one has one series of notes while the other has another and quite different series. The result suggests the combined notes of a Guinea-hen and a Turkey-hen, with occasionally the addition of others not unlike the yelping of a whipped puppy.

This singular concert was not given every day, and during my stay at the rest-house I heard it only half-a-dozen times. The birds call at sunset, and the cries of one pair seem to excite their neighbors, for, once started, the call is taken up and repeated by birds in different parts of the forest.

257. Aramus scolopaceus (*Gm.*).—CRAO.

Aramus guarauna LÉOTAUD, p. 489.

I saw, but failed to secure, one individual, presumably of this species, at the rest-house.

258. Nycticorax violaceus (*L.*). — YELLOW-CROWNED NIGHT HERON. CRABIER À CROISSANT.

TAYLOR, p. 95; LÉOTAUD, p. 433.

259. Nycticorax nycticorax nævius (*Bodd.*).—BLACK-CROWNED NIGHT HERON. CRABIER BATALI.

Nycticorax nævius LÉOTAUD, p. 431.

260. Ardea cyanura (*Vieill.*).—TCHOGUE. QUIOC.

Butorides virescens TAYLOR, p. 95.
Ardea grisea LÉOTAUD, p. 421.

Common. In habits this bird resembles *Ardea virescens*, but its notes are easily distinguishable from those of that species.

261. Ardea cærulea *Linn.* — LITTLE BLUE HERON. AIGRETTE BLEUE.

TAYLOR, p. 95; LÉOTAUD, p. 410.

Common at the mouth of the Caroni River.

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262. Ardea tricolor ruficollis (*Gosse*). — LOUISIANA HERON. AIGRETTE À VENTRE BLANC.

Ardea leucogaster LÉOTAUD, p. 424.

263. Ardea agami *Linn.*—AGAMI. BLONGIOS.

LÉOTAUD, p. 412.

264. Ardea candidissima *Gmel.* — SNOWY HERON. AIGRETTE À PANACHE.

LÉOTAUD, p. 408.

265. Ardea egretta *Gmel.* — WHITE EGRET. GRANDE AIGRETTE.

LÉOTAUD, p. 406.

Common at the mouth of the Caroni River, where, while fishing, they marked the limit of shoal water.

266. Ardea herodias *Linn.* — GREAT BLUE HERON. AILERONNE À CALOTTE BLANCHE.

LÉOTAUD, p. 404.

Léotaud remarks that he had seen only one example of this bird, probably the one now preserved in the Victoria Institute. This is a nearly adult specimen of *A. herodias*, and measures: wing, 18.75; tarsus, 7.12; exposed culmen, 5.00 in.

267. Ardea cocoi *Linn.*—AILERONNE.

LÉOTAUD, p. 401.

268. Ardetta involucris (*Vieill.*)—QUIOC JAUNE RAYÉ.

Ardea variegata LÉOTAUD, p. 419.

269. Ardetta exilis (*Gm.*).—LEAST BITTERN. QUIOC JAUNE.

Ardea exilis LÉOTAUD, p. 415.

270. Botaurus pinnatus (*Wagl.*).—BITTERN. BUTOR.

LÉOTAUD, p. 429.

271. Tigrisoma brasiliensis (*L.*).—RUSH CRABIER. CRABIER JONC.

LÉOTAUD, p. 426.

272. Cancroma cochlearia *Linn.*—BOAT-BILL. CRABIER BEC PLAT.

LÉOTAUD, p. 436.

273. Tantalus loculator *Linn.*—WOOD IBIS. SOLDAT.
LÉOTAUD, p. 438.

274. Guara rubra (*L.*).—SCARLET IBIS. FLAMANT.
Ibis rubra LÉOTAUD, p. 440.

275. Ajaja ajaja (*L.*).—ROSEATE SPOONBILL. SPATULE.
Platalea ajaja LÉOTAUD, p. 438.

276. Palamedea cornuta *Linn.*— KAMICHI. HORNED SCREAMER. CODINNE-BOIS.

LÉOTAUD, p. 488.

277. Cairina moschata (*L.*).—MUSCOVY DUCK. CANARD-PAYS.

LÉOTAUD, p. 521.

278. Dendrocygna discolor *Scl. & Salv.* — WHISTLING DUCK. OUIKIKI AILES BLANCHES.

Dendrocygna autumnalis LÉOTAUD, p. 507.

279. Dendrocygna viduata (*L.*).—TREE-DUCK. OUIKIKI BOURIKI.

LÉOTAUD, p. 509.

280. Dendrocygna fulva (*Gm.*). — FULVOUS TREE-DUCK. OUIKIKI AILES ROUGES.

Anas bicolor LÉOTAUD, p. 514.

281. Erismatura dominica (*L.*).—SQUAT-DUCK. VINGEON.
LÉOTAUD, p. 525.

282. Aythya affinis (*Eyt.*). — LESSER SCAUP. CANARD FRANCE.

Fuligula marila LÉOTAUD, p. 522.

283. Spatula clypeata *Linn.*—SHOVELLER. CANARD SPATULE.

LÉOTAUD, p. 518.

284. Anas discors *Linn.* — BLUE-WINGED TEAL. SARCELLE À CROISSANTS.

Pterocyanea discors LÉOTAUD, p. 516.

285. Anas americana *Gmel.* — AMERICAN WIDGEON. VINGEON.

Mareca americana LÉOTAUD, p. 511.

286. Fregata aquila (*L.*).—MAN-'O-WAR BIRD. FRÉGATE.

TAYLOR, p. 96; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Atagen aquila LÉOTAUD, p. 556.

Common in the Gulf of Paria. A small tree-grown rock at the entrance to the first Boca has for many years been famous as a roosting place for these birds. At the time of my visit about two hundred birds were perched upon the whitened trees. They were apparently all immature birds with white heads and breasts.

287. Pelecanus fuscus *Linn.*—BROWN PELICAN. GRAND-GOSIER.

TAYLOR, p. 96; LÉOTAUD, p. 552; RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.

A common bird in the Gulf of Paria.

288. Phalacrocorax brasiliensis (*Gm.*). — CORMORANT. PLONGEON À BEC CROCHU.

Graculus carbo? LÉOTAUD, p. 525.

289. Anhinga anhinga (*L.*).—ANHINGA. PLONGEON-SOIE.

Plotus anhinga LÉOTAUD, p. 548.

290. Sula leucogastra (*Bodd.*). — BLACK-AND-WHITE BOOBY. FOU COMMUN.

RIDGW. Proc. U. S. N. M. VII, 1884, p. 173.
Sula parva LÉOTAUD, p. 551.

291. Sula piscator (*L.*)—White Booby. Fou à pattes rouges.

Léotaud, p. 551; Ridgw. Proc. U. S. N. M. VII, 1884, p. 173.

292. Rhynchops nigra *Linn.*—Black Skimmer. Bec-en-ciseaux.

Léotaud, p. 534.

293. Anous stolidus (*L.*).—Noddy. Mauve noire.

Anous melanogenys Léotaud, p. 547.

294. Sterna antillarum (*Less.*).—Least Tern. Petite Mauve.

Sterna argentea Léotaud, p. 545.

295. Sterna dougalli *Montag.*—Roseate Tern. Mauve à bec noir.

Sterna paradisea Léotaud, p. 539.

296. Sterna eurygnatha *Saunders.*—Black-legged Tern. Grande Mauve à pattes noires.

Saunders P. Z. S. 1876, p. 655.
Sterna elegans Léotaud, p. 542.

297. Sterna maxima *Bodd.*—Royal Tern. Mauve à queue blanche.

Ridgw. Proc. U. S. N. M. VII, 1884, p. 173.
Sterna cayennensis Léotaud, p. 535.
Sterna regia, *ibid*, p. 543.

Several were observed at La Brea.

298. Phaethusa magnirostris (*Licht.*).—Yellow-footed Tern. Mauve à patte jaune soufre.

Sterna chlorispoda Léotaud, p. 537.

A bird of this species passed within gunshot of me at the mouth of the Caroni River, but was not secured.

299. Geochelidon nilotica (*Hasselq.*).—Marsh Tern. Mauve à dos cendré.

Sterna aranea Léotaud, p. 540.

300. Larus atricilla *Linn.*—LAUGHING GULL. PIGEON DE MER.

Larus ridibundus LÉOTAUD, p. 532.

301. Podilymbus podiceps (*L.*).—PIED-BILLED GREBE. PLONGEON.

Podilymbus carolinensis LÉOTAUD, 529.

302. Colymbus dominicus *Linn.*—SAN DOMINGO GREBE. PETIT PLONGEON.

Podiceps dominicus LÉOTAUD, p. 528.

303. Crypturus pileatus (*Bodd.*).—QUAIL. CAILLE.

Tinamus sovi LÉOTAUD, p. 385.

A very common bird, frequenting the borders of the forests, and occasionally found far in the woods. It is preëminently a ground bird, and, like a Rail, seeks safety by running through the dense undergrowth. Only once did I startle one into flying—a short, whirring flight of a few yards.

Their call is a liquid, plaintive, trilling whistle of three to five seconds duration, and uttered at intervals of half a minute to a minute. Rarely, however, it is given more rapidly, and whistle succeeds whistle with increasing volume until the limit of the performer's vocal powers is reached. I did not observe the birds while uttering this latter call, due, perhaps, to some unusual excitement, but when whistling under ordinary conditions they did not assume an unusual position, but, stopping, raised their head and trilled their musical call.

They are rather curious, unsuspicious birds, and an imitation of their notes would sometimes bring them to within a few feet of me, where they would remain some minutes, evidently looking for the unseen caller. It was unusual, except in rainy or cloudy weather, to hear them calling during the day, but just before sunrise and just after sunset they could be heard in numbers.

The following species, given by Léotaud, I am unable to identify.

304. Polytmus mellisugus.—SAPHIR-SAVANNE.
LÉOTAUD, p. 138.

Specimen not in Léotaud's Collection.

305. Columba caribæa *L.*?
LÉOTAUD, p. 558.

306. Nyroca leucopthalma.—CANARD ZIÉ-GRIS.
LÉOTAUD, p. 524.

Article II.—STUDIES OF SOME SPECIES OF NORTH AMERICAN ÆGERIIDÆ.

By WILLIAM BEUTENMÜLLER.

In advance of a monographic revision of the family Ægeriidæ of America north of Mexico, I herewith offer the following notes upon material chiefly contained in the Hy. Edwards Collection in the American Museum of Natural History. I have also appended translations of the descriptions of the species described by Boisduval, with the hope that these may be re-discovered. I have been unable to conclusively recognize any of Boisduval's species amongst the material accessible to me. In the whole of the Ægeriidæ the specific differences are very slight, though constant in most of the species, but it requires considerable attention and the careful comparison of species to distinguish one from the other. At first sight a box of these creatures would appear to be a number of individuals differing only in size, with here and there a slight change in the coloration. To the naked eye they present no more differences than a collection of Eleodes or Ichneumons. Another difficulty surrounding this group is that the larvæ feed within the stems of plants, and thus are not easy of access, while the work of raising them through their various stages becomes a task of no mean importance; moreover, the perfect insects are rarely found, and several years must elapse before the species of his own district comes into the hands of a collector. They also soon loose their scales through flight, and when pinned become covered with grease, and thus important characters are often lost; consequently considerable attention must be paid to the condition of the specimen before describing it.

Vespamima sequoiæ (*Hy. Edwards*).

Bembecia sequoiæ HY. EDWARDS, Papilio, I, 1881, p. 181.
Bembecia superba HY. EDWARDS, Papilio, I, 1881, p. 181.

Bembecia superba was described from a somewhat worn example, and it is identical with *Bembecia sequoiæ*. It is not a *Bembecia* but the type of an apparently new genus. It differs from *Bembecia* by having longer antennæ thickened at the apex, while those of *Bembecia* are tapering. The antennæ of the male have minute pectinations, while in *Bembecia* they are plumose. It also differs in venation and cut of the wings. The wings of *Bembecia*, especially the hind wing, are elongate with the hind angle much produced, while in the other genus the hind wings are more rounded. I propose the name *Vespamima* for this new genus.

Types: *B. sequoiæ.* Two males and two females from Mendocino Co., California. Coll. Hy. Edwards, Am. Mus. Nat. Hist. *B. superba.* One female, from Washington State. Coll. E. L. Graef.

Tirista admirandus (*Hy. Edwards*).

Sciapteron admirandus HY. EDWARDS, Papilio, II, 1882, p. 54.

This species it appears to me would be better placed in the genus *Tirista* of Walker (Cat. Br. Mus., pt. XXXI, 1864, p. 22). It differs from *Sciapteron* by the long plumose pectinations of the antennæ.

Type: One male, from Texas. Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Podosesia fraxini (*Lugger*).

Ægeria fraxini LUGGER (MS.) ORCUTT and ALDRICH, Bull. Agricul. Exp. Station, S. Dakota, March, 1891.
Trochilium fraxini LUGGER, Psyche, VI, 1891, p. 109, pl. iii, fig. 4.

This species does not belong to the genus *Trochilium*, but it appears to be more properly placed in the genus *Podosesia*. The venation is the same, and the cut of the wings and shape of the body are also similar. It only differs by having the antennæ minutely bipectinated. In coloration it differs from *P. syringæ* by the yellow bands on the first, second and third segments, and the other segments wholly yellow, as is also the underside of the body, while the body of *syringæ* is entirely brown above and below. The fore wings are light yellowish brown, dark brown in *syringæ*. The legs are yellow with only traces of a darker shade, while in *syringæ* they are distinctly black and yellow.

The hind wings are also paler in *fraxini*. One male from Miles City, Montana. Coll. Am. Mus. Nat. Hist. Presented by Mr. H. G. Dyar.

Parharmonia fraxini (*Hy. Edwards*).

Carmenta fraxini Hy. Edwards, Papilio, I, 1881, p. 185.
Harmonia morrisoni Hy. Edwards, Papilio, II, 1882, p. 54.

The genus *Harmonia* erected by Hy. Edwards is preoccupied in Coleoptera, having been established in 1846 by Mulsant for a genus in the Coccinellidæ. It therefore must be changed, and I propose for it the name *Parharmonia.*

Harmonia morrisoni Hy. Edw. is the same as *Carmenta fraxini* Hy. Edw., but the latter belongs to the genus *Parharmonia* and not to *Carmenta.*

Types: Male and female, Coll. Hy. Edwards, Am. Mus. Nat. Hist.; one male, Coll. C. V. Riley, Washington, D. C.

Habitat: New York, New Jersey, Washington, D. C., Missouri, Montana.

Parharmonia græfi (*Hy. Edwards*).

Sciapteron græfi Hy. Edwards, Papilio, I, 1881, p. 183.

This species does not belong to the genus *Sciapteron* but to *Parharmonia*.

Types: Coll. Hy. Edwards, Am. Mus. Nat. Hist. and Coll. E. L. Graef.

Habitat: Nevada.

Albuna pyramidalis (*Walker*).

Ægeria pyramidalis Walker, Cat. Lepid. B. Mus. pt. VIII, 1856, p. 40; Hy. Edwards, Papilio, I, 1891, p. 206.
Albuna vancouverensis Hy. Edwards, Papilio, I, 1881, p. 188; Grote's New Check List Moths, 1882, p. 12.

Albuna vancouverensis Hy. Edw. is the same as *Albuna pyramidalis* (Walker). The moth is black with a yellow band on the posterior edge of each abdominal segment. The fore wings have broad black borders with red along the inner margin; the outside of the transverse band is also narrowly edged with red as well as the inner side of the outer margin. The legs are black with yellow bands. *Albuna tanaceti* (=*Albuna montana*) and *Albuna torva* (=*Albuna coloradensis*) can be considered as nothing more than varieties or climatic forms of *Albuna pyramidalis*. *Albuna rubescens* is also a variety.

Habitat: Adirondack Mts., New York (Coll. E. L. Graef); Ontario, Canada; Colorado; N. W. Territory, Canada; Summit Sierra Nevada, California; Banff, B. C.; Mt. Hood, Oregon; Nevada; Vancouver Island. Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Albuna pyramidalis var. **montana** (*Hy. Edwards*).

Albuna montana Hy. Edwards, Papilio, I, 1881, p. 188; Grote's New Check List Moths, 1882, p. 12.
Albuna tanaceti Hy. Edwards, Papilio, I, 1881, p. 188.

This form differs from *pyramidalis* by having the yellow on the legs predominating and banded with black. The red on the primaries is also somewhat more distinct; otherwise it is the same as *pyramidalis*.

Habitat: Nova Scotia; Colorado; Sierra Nevada, Cal.; Vancouver Island (Coll. Hy. Edwards, Am. Mus. Nat. Hist.); Montreal, Canada (Coll. H. H. Lyman); White Mts., New Hampshire; Nevada; Anticosti Island (Coll. F. Tepper, Agricul. Coll., Michigan).

Albuna pyramidalis var. **rubescens** (*Hulst*).

Sesia rubescens Hulst, Bull. Brooklyn Ent. Soc. III, 1881, p. 76.

May be distinguished from the preceding form by having the red on the primaries quite distinct and considerably heavier. The legs are wholly yellow and of a deeper shade than in *montana*, and the abdominal bands are also darker.

Three females from Colorado (including the type). Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Albuna pyramidalis var. **coloradensis** (*Hy. Edwards*).

Albuna coloradensis Hy. Edwards, Papilio, I, 1881, p. 189; Grote's New Check List Moths, 1882, p. 12.
Albuna torva Hy. Edwards, Papilio, I, 1881, p. 189.

In this form the legs and body are wholly black without any traces of yellow markings whatever. The wings have the borders black without any traces of red as in the preceding forms, except a very slight indication of this color along the inner margin of the primaries.

Habitat: White Mts., N. H. (Coll. Mrs. A. T. Slosson); White Mts., N. H., and Anticosti Island (Coll. F. Tepper, Agricul. College, Michigan); Colorado, Vancouver Island and N. W. Territory, Canada (Coll. Hy. Edwards, Am. Mus. Nat. Hist.); Montreal, Canada (Coll. H. H. Lyman).

Ægeria lupini *Hy. Edwards.*

Ægeria lupini HY. EDWARDS, Papilio, I, 1881, p. 192; WM. BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. IV, 1893, p. 24.
Ægeria perplexa HY. EDWARDS, Papilio, I, 1881, p. 192.
Ægeria impropria HY. EDWARDS, Papilio, I, 1881, p. 193.
Ægeria washingtonia HY. EDWARDS, Papilio, I, 1881, p. 197.
Ægeria madariæ HY. EDWARDS, Papilio, I, 1882, p. 201; WM. BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. IV, 1893, p. 24.

In the Museum Bulletin, Vol. V, page 24, I united *Ægeria madariæ* with *Æ. lupini*. Since then close studies have been made of *Æ. perplexa*, *Æ. impropria*, and *Æ. washingtonia*, and I find that these do not differ from *Æ. lupini*. The species were described from specimens with the scales more or less abraded through flight and age. *Æ. perplexa* is a small male.

Types: *Æ. lupini*, *Æ. madariæ*, *Æ. washingtonia* and *Æ. impropria*. Coll. Hy. Edwards, Am. Mus. Nat. Hist. *Æ. perplexa*. Coll. B. Neumoegen; one authentic male. Coll. E. L. Graef.

Habitat: Washington, California, Nevada, Texas and Nova Scotia.

Ægeria saxifragæ *Hy. Edwards.*

Ægeria saxifragæ HY. EDWARDS, Papilio, I, 1881, p. 190.
Ægeria henshawi HY. EDWARDS, Papilio, II, 1882, p. 56.

Ægeria henshawi was described from a worn specimen, and is the same as *Æ. saxifragæ*.

Types: *Æ. saxifragæ*, one female from Colorado; *Æ. henshawi*, one female from Mingan Island, Labrador. Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Ægeria albicornis *Hy. Edwards.*

Ægeria albicornis Hy. Edwards, Papilio, I, 1881, p. 201.
Ægeria proxima Hy. Edwards, Papilio, I, 1881, p. 201.

This species has been reared from larvæ found under the bark of *Salix californica* (Proc. Ent. Soc. Wash., Vol. I, p. 85). I have also bred it from the trunks of young willows infested with larvæ of *Cryptorhynchus lapathi*. The male was described by Mr. Edwards as *Æ. proxima*. Judging from the description, I also consider *Albuna modesta* Kellicott the same as *Æ. albicornis*. It occurs from the Atlantic to the Pacific Coast. At present it is known from New York, New Jersey, White Mts., New Hampshire, Connecticut, Colorado, Nevada and California.

Types: *Æ. albicornis*, two females. Coll. Hy. Edwards, Am. Mus. Nat. Hist., and Coll. F. Tepper, Agricul. College, Michigan.

Ægeria lustrans (*Grote*).

Trochilium lustrans Grote, Can. Ent. XII, 1880, p. 213.
Ægeria lustrans Beutenmüller, Bull. Am. Mus. Nat. Hist. V, 1893, p. 25.
Ægeria bollii Hy. Edwards, Papilio, I, 1881, p. 191.

Ægeria bollii was described from a single male example from Texas, and it is identical with *Ægeria lustrans*.

Type: *Æ. lustrans*. Coll. Hy. Edwards, Am. Mus. Nat. Hist. *Æ. bollii*, one example, Coll. E. L. Graef.

Ægeria edwardsii, sp. nov.

Head and antennæ black; palpi white, black outside; coxæ of fore legs white, middle and hind legs deep brown; tibiæ pale yellow with a black band. Thorax blackish brown with traces of a very narrow stripe along the patagiæ. Body deep brown with a very slight purplish reflection, second segment and posterior edge of last segment with a narrow yellow band; fourth segment yellow. Underside with four pale yellow bands, one on the first and one on each of the last three segments. Anal tuft black with two small bunches of yellow scales above. Fore wings deep brown, with a slight purplish reflection with only a few short streaks of yellow before and after the indistinct discal spot. Hind wings with brown veins, outer border and scales brown; space between the veins pale orange; discal spot black. Underside of fore wings pale orange at base and the yellow streaks beyond the discal mark forming a spot. Hind wings same as above. Expanse, 20 mm.

One female, Denver, Colorado. Collected by Mr. D. Bruce. Type: Coll. Am. Mus. Nat. Hist.

Allied to *Ægeria verecunda* Hy. Edwards, but differs from it in the color of the wings and in other particulars. Named in honor of the late Hy. Edwards, who has contributed much to the knowledge of the North American Ægeriidæ.

Ægeria deceptiva, sp. nov.

Head and antennæ black; collar dull yellow; palpi yellow inside, black outside, as is also the last joint. Thorax black with traces of a yellow stripe on the patagia and a yellow mark on the posterior end. Body black with four distinct yellow bands; one on the posterior edge of each of the second and fourth segments, and two which occupy almost the whole of the last two segments. There are also faint traces of a band on the first, third and fifth segments; body beneath wholly yellow. Anal tuft above black at the sides and yellow in the middle and beneath. Thorax beneath black with a yellow spot on each side. Legs yellow banded with black. Fore wings transparent with narrow black borders and a transverse mark at the end of the cell of the same color. Hind wing also with narrow black border. Beneath the wings have the borders dull orange and the outer borders black. The transverse band dull orange in middle. Expanse, 25 mm.

Type: One male, from Colorado, Coll. Am. Mus. Nat. Hist. Collected and presented by Mr. David Bruce. The species is allied to *Æ. senecioides* Hy. Edw.

Ægeria culiciformis (*Linn.*).

Wings transparent, with a metallic blue margin, and the fore wings with a bar of the same color across and beyond the middle. Body blue black with an orange red band across the middle, above and below, and which is connected with a narrow stripe of the same color at the sides, running to the base of the body; palpi orange red; legs blue black; tarsi light orange. Thorax blue black with an orange spot on each side of the anterior part beneath. Underside of fore wings orange red along the costa. Antennæ black. Expanse, 23 mm.

A single male of this European species is in the collection of Mr. Charles Palm, collected by Mr. C. Weidt in the Cascade Mountains, British Columbia. This is the first record of its occurrence in this country.

Ægeria rutilans (*Hy. Edwards*).

Albuna rutilans HY. EDWARDS, Papilio, I, 1881, p. 186.
Ægeria aureola HY. EDWARDS, Papilio, I, 1881, p. 194.
Ægeria hemizoniæ HY. EDWARDS, Papilio, I, 1881, p. 198.

There are no differences between *Albuna rutilans* and *Ægeria hemizoniæ* to warrant their separation as distinct species. The latter was described from three worn examples. *Ægeria aureola* I consider only a small female of *rutilans*. The insect is more properly referred to *Ægeria* than to *Albuna*.

Types: Six females from Nevada and California. Coll. Hy. Edwards, Am. Mus. Nat. Hist. *Æ. aureola*. Coll. E. L. Graef.

Ægeria scitula *Harris*.

Ægeria scitula HARRIS, Am. Journ. Sc. and Arts, XXXVI, 1838, p. 313; WALKER, Cat. B. Mus. pt. VIII, 1856, p. 45; MORRIS, Synop. Lepid. N. Am. 1862, p. 141; BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 439.
Trochilium hospes WALSH, Proc. Ent. Soc. Phil. VI, 1866, p. 270; PACKARD, Fifth Rep. U. S. Ent. Comm. 1890, pp. 217, 270 and 296.
Trochilium gallivora WESTWOOD, Gardener's Chronicle, 1854, p. 757; Proc. Ent. Soc. London (2) III, 1854, p. 21; KELLICOTT, Can. Ent. XXIV, 1892, p. 45.

The type of *Ægeria scitula* in the Boston Society of Natural History was examined by me. It agrees in all particulars with an example bred by me from a larva found under the bark of chestnut, and a specimen bred by Rev. J. L. Zabriskie from the gall of *Andricus cornigerus* on oak (*Quercus palustris*). The specimens before me also agree with Walsh's description of *Trochilium hospes*, which was bred from a gall on willow; I also consider *Trochilium gallivora* identical with *Ægeria scitula*.

Ægeria rubristigma *Kellicott*.

Ægeria rubristigma KELLICOTT, Can. Ent. XXIV, Sept. 1892, p. 211; Insect Life, V, Nov. 1892, p. 84.
Ægeria asiliformis HY. EDWARDS, Papilio, II, 1882, p. 56.

The examples recorded from Massachusetts by the late Hy. Edwards as being identical with the European *Ægeria asiliformis* Rott, are a distinct species, and they fairly agree with the description of *Ægeria rubristigma*. A comparison of specimens of the two, however, is necessary to definitely decide this question. *Æ. rubristigma* was bred by Mr. Kellicott from a gall found on oak (*Quercus palustris*), and the so-called examples of *Æ. asiliformis* were bred from willow.

Pyrrhotænia polygoni *Hy. Edwards.*

Pyrrhotænia polygoni HY. EDWARDS, Papilio, I, 1881, p. 202.
Pyrrhotænia meadii HY. EDWARDS, Papilio, I, 1881, p. 204.

The female of this species was erroneously described as a male. *P. meadii* is the male of *P. polygoni.*

Types: Two males, Lake Tahoe, California, and one female, San Miguel, California. Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Pyrrhotænia fragariæ *Hy. Edwards.*

Pyrrhotænia fragariæ HY. EDWARDS, Papilio, I, 1881, p. 202; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. V, 1893, p. 26.
Pyrrhotænia helianthi HY. EDWARDS, Papilio, I, 1881, p. 203; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. V, 1893, p. 26.
Pyrrhotænia orthocarpi HY. EDWARDS, Papilio, I, 1881, p. 204.

In the Museum Bulletin, Vol. V, p. 26, I united *P. helianthi* with *P. fragariæ.* Since then I have come to the conclusion that *P. orthocarpi* is also a synonym of this species. *P. helianthi* and *P. fragaria* are the female and *P. orthocarpi* the male.

Types: *P. orthocarpi*, three males and one female from Nevada; *P. fragariæ*, one female from Colorado. Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Carmenta nigra, sp. nov.

Head and antennæ black; face and collar and underside of palpi sordid white; thorax and body black, the latter with three white bands on the posterior edge of the second, fourth and last segments; the middle band encircles the body while the other two are only present on the upper side; anal tuft black. Legs black with traces of whitish scales, especially on the anterior coxæ. Fore wings black, opaque, except a few short white streaks beyond the middle and a short white streak before the middle, thus giving rise to a black discal spot. Hind wings black, opaque. Expanse, 15 mm.

Type: One female from Utah. Coll. Chas. Palm.

Translations of Species Described by Boisduval.

Sesia mellinipennis *Boisduval.*

Sesia mellinipennis BOISDUVAL, Species Général, 1874, pl. xiv, 10 B. fig. 12; Suites à Buffon, Nat. Hist. Lépid. p. 402.

Head and antennæ black; palpi yellow; breast marked on each side with a yellow spot; posterior legs banded with black. Thorax black, with a ray on each and the collar yellow. Abdomen, blue black with five yellow rings of which two, on the first and second segments, are interrupted and the three others are situated at the extremity. Anal tuft yellow, middle black. Upper wings transparent with the borders and the transverse spot pale brownish black. Besides the transverse band is marked with a little red in its middle. Hind wings transparent with the veins and border pale brown.

It is a third larger than *cynipiformis*.

Habitat: North America. 2 ♂♂, which have been destroyed with several other American species by the powder explosion of the Luxemburg.

Sesia chrysidipennis *Boisduval.*

Sesia chrysidipennis BOISDUVAL, Lépid. California, 1869, p. 64; Suites à Buffon, Nat. Hist. Lépid. 1874, p. 403.

Head and antennæ black; palpi yellow white, brown above; collar straw yellow; corslet black; abdomen deep black with six yellow rings. The anal tuft black with the middle yellow. Thorax on each side with a yellow spot. Feet yellow; knees black. The wings are transparent with the internal border and apical nervures rusty buff; the costa brown; transverse band reddish buff on sides, brown in middle. Hind wings transparent; anterior border a little rusty; outer border, nervures and subcostal spot blackish brown.

It has the form of the European *S. uroceripennis*.

Habitat: Los Angeles, California.

Sesia anthracipennis *Boisduval.*

Sesia anthracipennis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 392.

Head and antennæ black; palpi yellow below with the last joint black on top. Breast of a brownish black; legs brown black. Body of a burnt brown with four yellow rings; anal tuft black, barely mixed with a few yellow hairs on the sides. Wings brown, marked with a small orange point on the space where the second spot is found transparent in most of the species. Hind wings transparent with a large border; the veins and subcostal lunule deep black.

Has the size and build of a very small *asiliformis.*

Georgia. Lives on a species of *Salix.*

Sesia bibionipennis *Boisduval.*

Sesia bibionipennis BOISDUVAL, Lépid. California, 1869, p. 64; Suites à Buffon, Nat. Hist. Lépid. 1874, p. 421.

Head and antennæ black; palpi grayish white below, black above. Corslet black. Feet brownish, limbs reddish brown (russet). Abdomen black with two rings of yellowish white. Anal tuft black mixed with a few yellow hairs and preceded in the male by a little white ring. Upper wings with two transparent spots, of which the anterior arrow-shaped, and the posterior round and divided into fine rays by the nervures. Hind wings transparent, nervures border and subcostal lunule black.

General appearance and size of *tenthreniformis* and near *S. bibioniformis* of Europe.

Habitat: California.

Sesia xiphiæformis *Boisduval.*

Sesia xiphiæformis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 409.

Head and antennæ bluish black; eyes reddish brown; palpi and feet black. Abdomen bluish black marked in the middle with a wide orange or rather two rings united, of a reddish buff. The anal tuft black, preceded in the male with a longitudinal buff dash, which does not reach the extremity of the brush. The upper wings entirely blackish brown with a fringe of light brown. Hind wings transparent with borders and nervures black. Also the anterior border is largely deep black. Expanse, 35 to 38 mm.

This large and beautiful *Sesia* differs a little from our European species. It is the type of a little group near *myopæformis* and *culiciformis*.

Habitat: United States.

Sesia nomadæpennis *Boisduval.*

Sesia nomadæpennis BOISDUVAL, Lépid. California, 1869, p. 63; Suites à Buffon, Nat. Hist. Lépid. 1874, p. 399.

Head black; collar and palpi yellow. Corslet bluish black. Abdomen also bluish black with three yellow rings. The upper wings transparent with the nervures, borders, extremity and transverse band deep black. The internal border is tinted with ferrugineous, and the apical extremity rayed with a little buff. The small transverse spot externally with a little ferrugineous. Hind wings transparent, nervures, border and subcostal spot black.

It has the size of the European *S. conopiformis* (*nomadiformis*).

Habitat: California.

Article III.—NOTES ON MAMMALS FROM NEW BRUNSWICK, WITH DESCRIPTION OF A NEW SPECIES OF EVOTOMYS.

By J. A. Allen.

The present paper is based on a collection of about 175 specimens, representing 21 species. The collection is one of the results of an expedition sent out by the Museum to New Brunswick, primarily for the purpose of securing proper accessories for a 'Moose Group,' now in process of preparation, the other results of the enterprise being incidental to the main purpose. The expedition was in charge of Mr. John Rowley, Jr., Chief of the Department of Taxidermy, who was accompanied by his brother, Mr. Charles P. Rowley, as a volunteer assistant. Mr. E. T. Adney also accompanied the party, rendering material aid and contributing to the success of the expedition.

About six weeks were spent in the field (Sept. 15 to Nov. 1, 1893), in the Tobique River region of New Brunswick. The area traversed extended from Andover, on the St. Johns River, to the Fork of the Tobique River, and thence to Trousers Lake,[1] a distance of about seventy-five miles.

The district is strictly Canadian, as shown by both the mammals and the birds obtained, among the latter being such forms as *Parus hudsonicus*, *Perisoreus canadensis*, *Loxia leucoptera*, *Picoides arcticus*, *Dendragopus canadensis*, and *Bonasa umbellus togatus*, of most of which good series were collected. The forest is wholly second-growth, the original growth having been long since removed by lumbermen.

While the number of species of mammals actually taken on the expedition is only 21, Mr. John Rowley, to whom I am indebted for all of the field notes given in the following list, has kindly furnished me with interesting information respecting a number of other species, which it has been thought best to place on record

[1] This lake is said to have received its name from its resemblance in outline to a pair of trousers.

in the present connection. His notes are distinguished by being inclosed in marks of quotation, and followed by the initial "R."

1. **Cariacus virginianus** (*Bodd.*). VIRGINIA DEER.—"Not common in the region of Trousers Lake, but found chiefly lower down the river, near clearings."—R.

2. **Alces machlis** (*Linn.*). MOOSE.—A fine old bull was killed by Mr. Rowley, for the Museum 'Moose Group,' at Gulquac Lake. A skeleton of another old male was also obtained, for which the Museum is indebted to the Hon. John Costigan of Ottawa.

"Moose were of frequent occurrence in the Trousers Lake region, having considerably increased during the last ten years, in consequence of legal protection."—R.

3. **Rangifer tarandus caribou** (*Kerr*). WOODLAND CARIBOU.—"Common everywhere, being found as far down the St. Johns River as Woodstock."—R.

4. **Vespertilio gryphus** *F. Cuvier.* BROWN BAT.—One specimen, Trousers Lake, Sept. 28. Others were seen.

I follow Dr. Harrison Allen (Mon. N. Am. Bats, 1893 (March, 1894), p. 75) in discarding the name *Vespertilio subulatus* Say, so long in use for this species, as indeterminable, and in any case inapplicable to the present species.

5. **Blarina talpoides** (*Gapper*).[1] SHORT-TAILED SHREW.—One specimen, Andover, Oct. 28.

6. **Sorex forsteri** *Rich.* FORSTER'S SHREW.—A series of 11 specimens is provisionally referred to this species, with the original description of which they seem sufficiently to agree. The average of the measurements taken from the fresh specimens by the collector is as follows: Total length, 99.5 mm. (3.92 in.); head and body, 70 mm. (2.75 in.); tail, 45 mm. (1.77 in.); hind foot, 12.5 mm. (.50 in.).

[1] On the proper name and relations of this species, *cf.* Miller, Proc. Boston Soc. Nat. Hist., XXVI, p. 185, March, 1894

"Apparently common everywhere, in all sorts of situations."—R.

7. **Scalops aquaticus** (*Linn.*). Common Mole.—"A mole, probably of this species, was evidently common about the settlements. No specimens were taken, but from the descriptions obtained of it, it was not the Star-nosed Mole (*Condylura cristata*)."—R.

8. **Lepus americanus** *Erxl.* Varying Hare.—This species is represented by 5 specimens taken Oct. 27 and 30, by 9 specimens taken Nov. 14–18, and by 15 specimens taken at various dates from Nov. 24 to Dec. 14, all at or near Andover. All, except the five first mentioned, were taken by Mr. A. Lockwood, after the return of the expedition. The 29 specimens form a series fully illustrating the autumnal change from the brown summer pelage to the white coat of winter. As this series, combined with other material in the Museum Collection, forms the subject of a special paper on the seasonal change of color in this species, to be published later in this volume, it is only necessary to note in the present connection that the specimens in which the character of the summer coat is still well shown present a wide range of variation in coloration—from pale-yellowish brown to deep-reddish brown, more or less strongly varied with black in different individuals.

Mr. Rowley informs me that this Hare is locally common in the region visited, being confined mainly to the cedar swamps.

9. **Erethizon dorsatus** (*Linn.*). Canada Porcupine.—Two specimens, Fork of Tobique, Sept. 20.

10. **Zapus insignis** *Miller.* Northern Jumping Mouse.—Three specimens, Tobique River, Sept. 21 and Oct. 9.

"Not an uncommon species in the long grass of the clearings, but they seemed to avoid the traps."—R.

11. **Mus decumanus** *Pallas.* Brown Rat.—One specimen, Andover, Oct. 29.

12. **Mus musculus** *Linn.* HOUSE MOUSE.—Andover. Several specimens, caught in the fields.

13. **Sitomys americanus canadensis** *Miller.*[1] CANADIAN WHITE-FOOTED MOUSE.—A series of 24 specimens is typically referable to *S. a. canadensis*, now for the first time represented in the Museum Collection. Nearly all are in the plumbeous coat, one only being fully adult. This form, as pointed out by Mr. Miller (l. c.), differs notably from the common White-footed Mouse of southern New England and further south.

"Very common about piles of logs in lumber camps, but also found generally distributed."—R.

14. **Arvicola riparius** *Ord.* MEADOW MOUSE.—Represented by 29 specimens, of which the greater part are immature; two of the adults are very strongly reddish brown.

"All of the specimens taken at Trousers Lake were trapped in the evergreen forests; at the Forks of the Tobique they were found only in the cleared land."—R.

15. **Arvicola chrotorrhinus** *Miller.*[2] RUFOUS-NOSED MEADOW MOUSE.—One specimen, ♀ ad., Trousers Lake, N. B., Oct. 7, 1893.

This specimen has been identified as above by Mr. Miller, who has compared it with the types of his *A. chrotorrhinus* from the White Mountains of New Hampshire, the only other locality from which it is thus far known. Mr. Miller's specimens were taken near the summit of Mt. Washington, N. H., July 12–15, 1893, hence nearly three months before the one above recorded.

"This specimen was taken in a small opening in the spruce woods. Two others were taken, but were so badly mutilated by the traps that they were not saved."—R.

16. **Evotomys gapperi** (*Vig.*). RED-BACKED MOUSE.—Represented by a series of 40 specimens, of which about one-half are adult and the rest in various stages of immaturity. One has a conspicuous patch of white on the back, due to albinism.

[1] Proc. Biol. Soc. Washington, VIII, 1893, p. 55.
[2] Proc. Boston Soc. Nat. Hist., XXVI, p. 190, March 24, 1894.

"This is the common Mouse of the region, being found abundantly everywhere, but perhaps rather more numerously in the spruce woods than in the clearings."—R.

17. **Evotomys fuscodorsalis**, sp. nov.

Smaller than *E. gapperi*, and very differently colored, but similar in proportions. Middle of dorsal region, from crown to base of tail, dusky brown, forming a broad blackish dorsal area; sides light, rather ashy, mouse-gray; below light whitish gray, the hairs dark plumbeous for their basal two-thirds, apically whitish gray. Ears prominent, clothed with short brown hair. Fore feet light gray; hind feet dusky gray. Tail bicolored, above dusky brown, blackish at the extreme tip; lower surface light whitish ashy.

The two specimens measure as follows:[1] ♂, total length, 129 mm. (5.06 in.); head and body, 89 mm. (3.50 in.); tail, 40 mm. (1.56 in.); hind foot, 16.5 mm. (.65 in.); ear from crown, 7.6 mm. (.30 in.); ♀, total length, 127 mm. (5.00 in.); head and body, 90 mm. (3.56 in.); tail, 37 mm. (1.44 in.); hind foot, 18 mm. (.70 in.); ear from crown, 7.6 mm. (.30 in.).

Skull, ♂ ad.—Total length (front border of nasals to occip. cond.), 23.4 mm. (.92 in.); basal length (inner base of incisors to occip. cond.), 20.5 mm. (.81 in.); greatest zygomatic breadth, 12.7 mm. (.50 in.); greatest width of brain-case, 11.7 mm. (.46 in.); least interorbital breadth, 4 mm. (.16 in.); length of nasals, 9.4 mm. (.37 in.); length of anterior palatine foramen, 4.3 mm. (.17 in.); length of crown surface of upper molar series, 8.1 mm. (.22 in.); length of lower jaw (point of incisors to post. edge of cond.), 10.7 mm. (.42 in.); height at coronoid process, 4.3 mm. (.17 in.).

Type, No. $\frac{6658}{5278}$, ♂ ad., Trousers Lake, N. B., Oct. 17, 1893; C. P. and J. Rowley.

This species is based on two specimens, male and female, taken at Trousers Lake, Oct. 17. Although full grown, neither is apparently very old.

In coloration this species strongly resembles the species of *Phenacomys*, to which genus it was presumed to be referable until an examination was made of the skull and dentition, which show that it is clearly referable to *Evotomys*. It therefore does not require comparison with any other species of the genus. The pattern of coloration is the same as in *E. gapperi*, the red color of the back in that species being replaced with blackish brown in *E.*

[1] Measurements, except of ear, from the fresh specimens, by the collector.

fuscodorsalis. As regards size, *E. gapperi* from the same locality averages considerably larger, 10 adults averaging as follows: Total length, 144 mm. (5.67 in.); head and body, 101 mm. (3.97 in.); tail, 43 mm. (1.70 in.); hind foot, 20.3 mm. (.80 in.).

18. **Fiber zibethicus** (*Linn.*). MUSKRAT.—Trousers Lake and vicinity of Andover, Sept. 28–Oct. 27. A series of 10 specimens.

"Abundant in all suitable localities."—R.

19. **Tamias striatus lysteri** (*Rich.*). NORTHERN CHIPMUNK.—One specimen, Trousers Lake, Oct. 15.

"Common lower down the river, and probably also on the hardwood ridges about Trousers Lake. This, however, was the only one seen, probably owing to the lateness of the season."—R.

20. **Sciurus hudsonius** *Pallas*. RED SQUIRREL.—Represented by a series of 14 specimens, taken at various localities, Sept. 23 to Oct. 17. All are in rather thin pelage, molting from the summer to the winter coat. The black lateral line is more or less distinct in all.

"Common everywhere, sometimes probably a hundred being seen in a single day."—R.

21. **Sciuropterus volucella sabrinus** (*Shaw*). FLYING SQUIRREL.—"More or less common."—R.

22. **Arctomys monax** *Gmel.*—"Not uncommon about the settlements."—R.

23. **Castor canadensis** *Kuhl.* BEAVER.—A fine specimen, now in the mounted collection of the Museum, was taken Oct. 20 on the Tobique River.

"Now becoming scarce. Saw but one fresh beaver dam, but remains of old ones were frequently met with."—R.

24. **Ursus americanus** *Pallas*. BLACK BEAR.—"More plentiful near the settlements than in the forests. We were much annoyed by bears destroying our sable traps."—R.

25. Procyon lotor (*Linn.*). RACCOON.—"Quite common. Thirty were taken by Mr. John Costigan of Ottawa, who was trapping here, during the six weeks of our stay in the region."—R.

26. Lutra hudsonica (*Lacép.*). OTTER.—"Not uncommon. Many are caught for their fur by trappers."—R.

27 Mephitis mephitica (*Shaw*). SKUNK.—"Found at Andover and Riley Brook, but apparently not common."— R.

28. Lutreola vison (*Schreber*). MINK.—The collection contains three specimens taken at Trousers Lake.

"Not uncommon."—R.

29. Putorius erminea (*Linn.*). ERMINE; WEASEL.—Two specimens, in summer pelage, taken at Trousers Lake, Sept. 30 and Oct. 15.

30. Mustela pennanti *Erxl.* BLACK CAT; FISHER.—"Not uncommon. One of the animals forming the chief dependence of the trappers in their pursuit of furs."—R.

31. Mustela americana *Turton.* MARTEN; AMERICAN SABLE.—Two specimens, Trousers Lake, Oct. 7 and 10. Both are very richly colored, the breast patch being deep orange ochre.

"This is one of the most abundant of the fur-bearing species."—R.

32. Vulpes fulvus (*Desm.*). RED FOX; SILVER FOX.—"Common about the clearings. The 'Silver' or 'Cross' Fox is frequently taken, but the common form is of course much the more abundant."—R.

Mr. Rowley informs me that the Gray Wolf (*Canis lupus griseo-albus*) has been, so far as he could learn from extended inquiries, quite extinct in this region for many years. Even one of the oldest Indian trappers he met had never seen one.

33. **Lynx canadensis** *Raf.* Canada Lynx.—"Reputed to be not uncommon."—R.

"The Panther (*Felis concolor*) is said to occur, but no satisfactory evidence of its present existence in the region was obtained."—R.

Article IV.—ON THE SEASONAL CHANGE OF COLOR IN THE VARYING HARE (LEPUS AMERICANUS ERXL.).

By J. A. Allen.

Introductory.

Any one at all familiar with the seasonal changes of color in mammals, and also with the periodic shedding and renewal of the pelage, cannot have failed to note the coincidence of the two phenomena. As a rule, particularly among the Rodentia, the change becomes first apparent on the feet and about the nose, extending gradually up the limbs and over the head, and from the base of the tail anteriorly, and from the sides of the body toward the median line. This, perhaps, may be assumed to be the usual method, particularly in the spring molt, but the process is subject to much irregularity, even among individuals of the same species, and it seems to vary somewhat in different groups.[1] Late in spring, usually at the close of the breeding season, the old coat has become worn, faded, and more or less ragged, and the new hair may be seen coming in irregularly in patches, in addition to the more symmetrical method of change already indicated.

The new hair, forming the summer coat, is much shorter and thinner, and usually brighter in color than the coat it replaces. The change from this coat to the winter dress again is generally accomplished more or less insidiously, but apparently in much the same order as in the case of the change from the winter to the summer coat. The summer coat is worn usually for a much shorter period, and fails to show the same amount of wear and fading, so that the transition is generally less marked and abrupt; the new hair comes in gradually, and overtops the short summer coat, which apparently falls out as the new hair becomes more abundant and longer. Only in the case of some more or less radical change in color can the progress of the fall molt be readily traced,

[1] Thus in the Hares, as will be shown later, it is quite different from what it is in the Squirrels.

as in the Varying Hares, forming the subject of the present article. In these a brown summer pelage is replaced by a white winter coat; and the change is thus so radical that it should seemingly be an easy matter to determine how it is produced. Yet just how the change of color is effected is still to some extent a matter of dispute. While supposed to be largely due to a molt, it sometimes appears to take place so suddenly that it is popularly thought to be due, in some degree at least, to the blanching of the summer hair.

Character of the Pelage.

In order to understand fully the remarks that follow, it is necessary to briefly describe the summer and the winter pelage.

Summer Pelage.—The general color of the upper parts, including the limbs externally, varies in different individuals from pale yellowish gray to deep yellowish brown, and even occasionally to reddish brown, more or less varied with blackish, particularly over the middle and posterior part of the back, due in part to most of the hairs being tipped with black, but often mainly to a strong sprinkling of wholly deep black hairs. There is also a broad pectoral band or 'ruff,' varying from two to three inches in breadth, and in color from yellowish gray to deep rusty fawn. The rest of the lower surface, including the chin and throat, a part of the inner side of the hind limbs, and the whole of the ventral surface posterior to the breast, is white, often washed slightly with fulvous or grayish. The ears are brownish, more or less rusty, the extreme edge whitish, particularly on the posterior border, the apical third externally with a submargin of black, expanding towards the tip into a broad blackish subapical spot. Except basally and along the anterior border, the ears are thinly haired throughout. The soles of the feet are generally more or less dusky.

This pelage, considered in detail, consists of two distinct parts—a thick woolly underfur, and a heavy coat of long overhair. The underfur is plumbeous basally, generally for about two-thirds of its length, with the apical third fulvous or tawny, the exact shade varying in different individuals.

The overhair is of two kinds, as regards both pattern of color and structure. It consists principally of particolored hairs, which are plumbeous basally, generally about as far as the plumbeous zone of the underfur, then blackish for about one-half their total length, then passing abruptly into a broad band of fulvous, and then again abruptly into black at the extreme tip. These hairs are extremely attenuated at the base, gradually thicken as they become black, attaining their greatest diameter at and throughout the subapical fulvous zone, and then rapidly taper to a fine-pointed tip. Mingled with these particolored hairs is a greater or less profusion of wholly black, rather longer hairs, of coarser and firmer texture. These hairs vary greatly in abundance in different individuals, and over different parts of the body, being most abundant along the middle and posterior part of the back. They taper slightly towards the base and tip, but are of a much more uniform diameter than are the particolored hairs. They overtop the particolored hairs, thus not only greatly increasing the blackish cast of the dorsal surface, but by their rigidity imparting greater firmness to the surface of the pelage.

During the autumnal change the particolored hairs are the first to fall out; the longer, firmer, wholly black hairs persist later, quite a proportion of them often remaining after the particolored hairs have disappeared, giving a more or less leaden or dingy effect to the otherwise white winter coat. This effect gradually passes away, although a few black hairs can be found in most early December specimens, but they generally wholly disappear by the middle or during the last half of the month, excepting at southern localities.

Winter Pelage.—Generally everywhere white at the surface, except the tips and edges of the ears, and the soles of the feet, although the latter are much lighter in color than in summer.

The winter pelage is, of course, also made up of two kinds of hair—a woolly underfur, rather longer and much more abundant than in summer, and the longer, coarser, firmer overhair. The underfur is colored much as in summer, except that the tips of the longer fibres are pure white, like the overhair. The overhair is almost invariably pure white from base to tip, although the extreme basal portions of some of the hairs are grayish and pass into a horn-gray middle zone. This condition is rare, occurring in comparatively few specimens, and then only in a very small percentage of the hairs making up the long white coat of overhair. The hairs composing the white covering of overhair vary greatly in diameter, not only in different individuals, but in different parts of the body of the same animal, and even from the same region, as from the middle of the back. The coarser hairs have a firm shaft from the tip to the point of insertion into the skin; the finer hairs have only the outer half or two-thirds firm and shaftlike, the lower portion dwindling to a thin filament, and when detached is curly and not unlike one of the coarser fibres of underfur. There is indeed, in some individuals, an almost complete intergradation as regards texture between the coarser overhair and the longer white-tipped filaments of underfur.

Material Examined.

The following observations are based on a series of about 75 specimens, nearly all of which belong to the Museum Collection.[1] The greater part have been collected for the express purpose of this investigation, and include specimens taken through both the autumnal and vernal changes, as well as at other seasons. About thirty were collected near Andover, New Brunswick, during October, November and December (Oct. 27–Dec. 14), 1894, for the purpose of securing a series showing the transition from the brown summer coat to the white dress of winter. A part of this series was obtained by Mr. J. Rowley, Jr., and his associates, on the recent Museum Expedition to New Brunswick (see *antea*, pp. 99 and 101), and the rest were secured later from an Indian hunter through Mr. Rowley's agency. The greater part of the rest of the series is from the vicinity of Rutland, Vermont, taken at various intervals from Oct. 17 to April 15, and for which I am mainly indebted to Mr. W. W. Granger, who has also kindly secured a series, collected at intervals during March and April, to illustrate the spring molt. There are also four specimens from Kittson County, Minn. (Nov. 17–22), collected and presented by Dr. E. A. Mearns.

This material shows that there is considerable individual variation in respect to the exact time of change at the same locality. Thus some of the specimens taken as early as Nov. 17, both

[1] I am indebted to Dr. C. Hart Merriam, of Washington, for the loan of 13 specimens from his own collection, which have proved especially useful in the present connection. Six of them are from the Adirondack region of New York, and seven from Elk River, Minn. The former include specimens taken in summer and autumn, while the latter were taken during the spring molt.

at Rutland, Vt., and in New Brunswick, are already quite white, while others taken at the same locality and on the same day show very little change from the summer coat. Most of the specimens taken the last week in November are in nearly full winter dress, but in some the change is much less advanced. March and April specimens also show a wide range of variation in respect to the spring molt, some individuals changing much earlier than others.

Autumnal Change.

The early stages of the autumnal change are well shown in five New Brunswick specimens taken Oct. 27-30. In two of these only the sides of the nose, the ears and the feet have become white, the white extending, however, on the fore limbs nearly to the body, and on the hind limbs over the inner edge of the leg to the thigh, with a strong admixture of white hairs all around nearly to the knee. Another specimen is similar except that the ears are much less white and the white extends higher on the sides of the nose. The fourth specimen (No. 6737) is more advanced, the whole top of the nose, nearly to the eyes, being quite whitish, while a broad whitish streak extends backward from this whitish frontal area to the base of the ears. On parting the fur an abundance of short white hairs is seen along the sides of the body and across the rump and lower part of the back. A close examination of the light areas on the front and sides of the head shows that the whiteness is due to a new growth of hair, which in places has almost wholly replaced the brown coat, but is generally mixed with it; on parting the adjoining and still superficially unchanged area an abundance of short white hairs is found which have not yet reached the surface. In the fifth specimen (No. 6739) the change is less advanced on the head, but more advanced on the sides and posterior part of the body, which parts are already more or less whitish, particularly on the thighs, where the greater part of the long hairs of the summer coat have fallen out and the white winter coat begins to show, though it is still largely concealed within the underfur. On the right side of the median line, in front of the hips, are several small irregular patches of white, due to the almost entire falling out of the summer pile, although the thick winter pile here developed is still much shorter than the surrounding pelage.

The next set of twelve specimens was taken some two weeks later (Nov. 14–17), yet, through individual variation, they continue by insensible gradations the stages of change, almost to the full winter coat. No. 6788 of this series is even less advanced than Nos. 6737 and 6739, already noticed. Three or four others are so nearly like these two as not to call for special mention. No. 6791 is a little more advanced, and shows beautifully the progress of change on the head. The whole top of the head, from between the base of the ears to a point somewhat in front of the eyes, is apparently unchanged, forming a large crown patch about twice as long as broad, bounded in front by a pure white nose patch, and on the sides by a broad whitish ocular band, leaving on either side below this a broad, nearly unchanged, malar region, extending forward in a point toward the nostril. The hairs forming the white nose patch are still short, though the longer brown hairs of the old coat have entirely disappeared. The transition to the brown crown patch is abrupt, but on parting the hairs at its anterior border the pelage is found to be thickly set with short, pure white hairs that have not yet reached the surface. The tawny pectoral ruff has become considerably whitened by the incoming white hairs, some of which have nearly reached their full length. One or two of the other specimens already mentioned show the pectoral ruff in about the same condition ; in others only a few white hairs have appeared, while in still others it remains practically unchanged at the surface, although on separating the pelage white hairs are found beneath the surface.

No. 3240 (Rutland, Vt., Nov. 17) carries the change considerably further. The whole pelage has become more or less whitened, but there is still a sufficient remnant of the summer coat over the dorsal region to give the prevailing tint to the central portion of the back, gradually fading thence laterally till white becomes the prevailing tint at a point quite high up on the sides of the body. The white nose patch extends laterally to the eyes and centrally in a broad point to the middle of the interocular space, while the whole crown is irregularly whitish, small patches where white prevails being mixed with patches of the summer coat, which is one-third to one-half longer than the new winter coat. This results in giving to the whole top of the head the ragged, patchy appearance so often seen in molting animals, and shows at a glance and beyond question that the change of color is due to a replacement of the summer coat by a winter coat of a different color, and that the whiteness of winter is not due to a change of color in the summer coat. The whole dorsal region is thickly set also with white hairs, but few of which have reached the surface, although a considerable part of the long pile of the summer coat has been shed, except over a narrow band along the median line, extending from the loins to the head and widening anteriorly. The sides of the head have still undergone little change.

Another specimen (No. 3242, same date and locality) is a little more advanced, but presents the same general features, including the rough, patchy appearance of the head. There is, however, much less of the summer coat left over the dorsal region. In No. 3241 (same date and locality) the change is nearly complete, only the black hairs of the dorsal region remaining of the summer coat, producing a general grizzled effect.

The New Brunswick specimens furnish a parallel series to those from Vermont, last described. Other specimens of the New Brunswick series taken later (Nov. 20, 24 and 26) present interesting phases of change. No. 6828 (Nov. 20) has a considerable mixture of the summer coat remaining on the crown, cheeks, ears and shoulders, and less (but still enough to produce a grizzled, dingy effect) over much of the dorsal region. No. 6831 (Nov. 26) has a large part of the top of the head still brown, with much brown hair over the shoulders and along the median line of the back, extending as a narrow band from the nape posteriorly for about two-thirds the length of the body, decreasing in width posteriorly and becoming gradually obsolete. No. 6829 (Nov. 24) has the crown almost unchanged, forming a cap of brown hair projecting above the surrounding white pelage; and there is a very slight admixture of the summer coat over the middle of the back. A specimen taken later (No. 6837, Dec. 6) is nearly white throughout, but is slightly tinged with brown hairs on the back, while the head is piebald through the presence of small spots of brown on the white ground. The hind feet, particularly near the base of the toes, are streaked with fawn color on a white ground, while the anterior surface of the fore limbs is mainly deep fawn color. But it does not follow that the fawn-colored pelage of the feet is a remnant of the summer coat, since this is found also in specimens killed in January and March, the series of specimens covering the period from November to March showing that this is an individual peculiarity, different specimens presenting a gradation from white to fawn-colored feet independently of season.

The December series (Nov. 29 to Dec. 15) shows that after the white color is practically assumed it increases in purity, as does the coat in softness and fullness, by the maturing or lengthening of the white overhair and the thickening of the soft underfur. The long black hairs of the summer coat are the last to disappear, being retained, apparently to give firmness and stability to the pelage, till the white overhair of the winter coat is fully developed.

From the foregoing it will be seen that the Varying Hare has an autumnal molt, not unlike that occurring in other mammals, to which alone the change of color is due;[1] and, furthermore, that the change begins and proceeds in the manner, so well known to every one who has given careful attention to the subject, common to other mammals; it beginning with the nose, feet and ears, extending gradually, sometimes somewhat irregularly, over the head, up the limbs and along the flanks, creeping gradually up the sides toward the median line of the back, and from the rump anteriorly, leaving the crown, the sides of the head (malar regions), and the anterior and median portions of the back as the parts last to undergo the change of coat. Indeed, so simple and so matter of course is the whole process, that the only excuse for giving so detailed an account of the change is the fact that exceedingly erroneous statements of the process have not only found their way into print, but have also been made the basis of other generalizations.

[1] In addition to the evidence of a molt afforded by skins, as already given, I am assured by Mr. Rowley and Mr. Granger, independently of each other, that they noticed in preparing the skins of the fall specimens in change that the long brown hairs came out very freely, while there was no noticeable shedding of the white hairs.

VERNAL CHANGE.

My studies of the vernal change are based primarily on specimens taken in the vicinity of Hartland, Vermont, during the present spring (1894)—a season remarkable for the great and almost unprecedented warmth of the first three weeks of the month of March. Hence the molt may have begun this year somewhat earlier than usual for this locality. This series is admirably supplemented by a series from Elk River, Minn., taken March 24 to May 11, 1886, kindly loaned me by Dr. C. Hart Merriam from his private collection for use in the present connection.

Three specimens, taken March 25, present the following conditions: No. 7289, ♂, differs little in superficial appearance from midwinter specimens. A close examination, however, shows that it has already lost the long soft white overhair from the ears—so conspicuous a feature of the basal portion in winter examples—and that a portion of the long white overhair of the body has been lost. On separating the pelage a few small patches of the summer pelage can be found here and there, where by accident, or in fighting, the old hair has been torn out, and the new coat has come in, as on the shoulders and hips. Here the summer coat, only a few millimeters in length, is coming in in a uniform, compact mass. It presents all the characteristics of the summer coat, as far as it has advanced, generally showing only the black tips and a portion of the broad subapical zone of fulvous.

A second specimen (No. 7290, ♂) is almost precisely similar, except that the hairs of one of the small patches of new fur on the middle of the back are more than half grown, thus showing a part of the black basal portion below the fulvous zone. A third specimen (No. 7288, ♀) is quite different, having shed *nearly all of the long overhair*, only a few scattered white bristly hairs remaining, so few that they might be easily counted. The heavy coat of long thick underfur, however, remains apparently intact, and, strange to say, the animal looks *nearly as white as before it lost its overhair*. It serves to show in a striking manner that the surface of the underfur is also white, as well as the overhair; and having seen it thus demonstrated, it is easy now to discover on careful examination, that the surface of the underfur is generally white in winter specimens. This specimen also shows numerous patches of new hair on the back where the old coat has been violently removed.

Two specimens, taken April 1 and 2, exhibit the progress of ten days. In both of these (No. 7285, ♂, and No. 7286, ♀) the greater part of the overhair has been shed, and there has evidently been a great reduction in the amount of underfur. In addition to this the new summer fur can be seen coming in somewhat uniformly over most parts of the body; though somewhat thinly dispersed it can be easily seen on parting the underfur.

Two specimens killed April 9 (Nos. 7291 and 7292) carry the change much further. No. 7291, ♀, has lost all of the winter coat of overhair, except here and there a few remotely isolated hairs. The patches of new hair, replacing bunches lost by accident, have now reached the level of the still heavy coat of underfur. There is less short new hair generally dispersed over the body than was found in the two specimens of a week earlier date, above described; but very interesting changes have taken place on the head, and on the summit of the shoulders, where a large increment of the summer fur has risen to the surface of the underfur. A large part of the white hairs of the winter coat still cover the sides and top of the nose and extend back in a triangular patch to a point between the orbits; but on either side of this median line, from a point considerably in advance of the eyes back nearly to the crown, the summer pelage is quite fully developed, and the winter hair has disappeared. A similar patch occupies the upper part of the cheeks, just below the eyes, and new summer hair is abundantly dispersed throughout the crown.

No. 7292, ♂, is much more advanced. There are scattered new hairs over much of the body, as yet concealed by the overtopping underfur; the feet, particularly the hind feet, are more advanced in change, and the whole head, including the cheeks, has become invested with the summer coat. The pelage is still short, and in places presents a patchy appearance, as over the nose and on the posterior part of the cheeks, where irregular tufts of the winter coat remain, conspicuous by its greater length and white color. The ears appear practically unchanged, retaining an unusual amount, compared with the other April specimens, of the long, white winter hair. Over the shoulders and on the hinder part of the back are numerous patches of the nearly full-grown summer pelage, with its characteristic mixture of fulvous-barred and black-tipped hairs.

Of two specimens taken April 15 one (No. 7295, ♂) is less advanced than No. 7292 (described above), taken a week earlier, it still retaining much of the long white overhair over the posterior third of the back, and the ears are nearly as white and as well clothed as in winter; and generally the specimen is in a very backward condition of change. The other (No. 7294, ♀) is in a very advanced stage of change, excepting the ears and feet, which still remain nearly as in midwinter. The entire head, the pectoral ruff, and the whole central part of the dorsal region nearly back to the hips, have taken on the characteristic dress of summer, the summer pelage protruding above the underfur, though not yet of mature length. There still remain, however, many long white hairs over the middle of the back, especially posteriorly, and there are small tufts of white hair on the sides of the head. On the sides of the body and over the posterior part of the back the summer coat is largely concealed beneath the still persistent winter underfur.

These are the last of the Vermont series received up to the date of this writing, but fortunately the specimens from Elk River, Minn., already mentioned as received from Dr. Merriam, carry the change forward to almost full summer pelage. These will be described somewhat in detail, although covering in part the ground already traversed, the locality rendering them of especial interest in this connection. The seven specimens were taken at such well chosen intervals (March 24 to May 11) that they show the leading stages of change throughout the whole period of molt.

No. 2545 (Coll. Dr. C. Hart Merriam), ♂ ad., March 24, has begun to lose the long white overhair, particularly on the ears, sides of the shoulders and middle of the back, and patches of the new summer coat have appeared on the front of the head near the eyes, that on the left side being about twice as large as the one on the right side. Another specimen (♀), taken March 27, is slightly more advanced, having lost most of the long white overhair from the back, and over which area considerable new hair has just appeared above the skin, as can be seen by carefully parting the underfur.

No. 2546, ♀, April 1, has lost nearly all of the long white overhair, except from the ears and feet, and the new summer pelage is coming in abundantly and quite evenly over nearly the whole dorsal surface, including the sides of the body as well as the back, much of it being already 5 or 6 millimetres in length; while little patches here and there have reached the surface of the underfur, and over a large part of the head it has quite replaced the winter coat. No. 2551, ♀, April 7, is a little more advanced, the summer pelage being well developed over the whole head, except a small central area in front, over the nasal bones, and has attained considerable length over the whole dorsal surface, though still buried in the winter underfur. A few long white hairs are scattered over the dorsum—remnants of the winter coat of long white overhair.

In No. 2549, ♀, April 8, the summer pelage thickly clothes the head, sides of the shoulders and a very broad area on the back, extending as far back as the hips. Over all these parts it overtops the underfur, and gives to the surface of the pelage the characteristic color and texture of the summer dress. From the hips, posteriorly, and along the sides of the body, it is much less abundant and still concealed beneath the underfur.

The next specimen in the series (No. 2555, ♂) was taken April 23, and is nearly in full summer dress, except on the feet and ears, although the pelage is still short. There are little tufts of white hairs—remnants of the winter coat—still remaining here and there on the back and sides. This is the first specimen of the Elk River series that shows much change in the pectoral ruff or on the feet, the ruff in this example having taken on the character of the summer dress. On the forearm the summer pelage has advanced on the outer side to a point about half way between the elbow and wrist, superseding the winter coat, and below this point much of the winter coat has either fallen out or worn off. On the hind feet a nearly complete change has advanced as far as the ankle joint, and the feet are ragged and worn, having lost much of the winter coat.

The last specimen of the Elk River series (No. 2553, ♀, May 11) has practically attained, so far as the head and body are concerned, the summer dress, except that the pelage appears not to have attained its mature length. The ears and tail still show traces of the winter pelage, and the feet are but little more advanced in change than in the specimen last described.

From the foregoing it is obvious that the spring molt, like the autumnal, occupies a period of from fully four to six weeks, the latter probably being about the average length of time required for the complete change of dress.

In tracing the change from the winter to the summer coat we have spoken only of the change of the overhair. A comparison, however, of the specimens last mentioned with those first described in the Elk River series, or of summer with winter specimens, renders it evident that the underfur is changed as well as the overhair. The summer underfur is at least three-fourths less in amount, is shorter, and apically quite different in color. It appears to grow simultaneously with the overhair, the old coat of underfur being retained as a protection from cold for some time after the winter overhair has fallen out, and much later giving place gradually to the new coat, as the latter becomes sufficiently developed to afford the necessary amount of warmth. Whether or not the summer underfur is molted in autumn it seems almost impossible to determine, but that there is at this season a heavy growth of new underfur is plainly obvious.

Irregularities in Change of Color, etc.

An examination of the present series discloses various irregularities in the development of the white winter dress, in respect especially to the color of the feet, ears and head. In most specimens that have completed the winter dress the feet, except the soles, are superficially white, the whiteness varying greatly in purity in different specimens, while others, particularly on the fore feet, present large areas of fulvous. In those with the whitest feet, the hairs are wholly white to the base, and the underfur is pale plumbeous, with no tinge of fulvous. In other specimens the underfur varies from pale fulvous to deep rich fulvous, and in these latter the hair basally, in part or wholly, has the same tint, the hairs varying, in different specimens and also over different parts of the same foot, from pure white nearly or quite to the base to wholly fulvous, or fulvous with a white tip of variable extent in different hairs situated in close proximity. In this way the dorsal aspect of the foot varies from uniform clear white to white mixed more or less irregularly with fulvous, or to nearly deep pure fulvous, shading off laterally or at the edges into white.

The ears vary similarly except that the underfur is more commonly dusky, and the white surface is varied with dark chestnut or rusty brown rather than fulvous.

Usually in the specimens with brownish ears and fulvous feet the whole head shows a tinge of fulvous, which proves to be due in part to the shortness of the white tips to the hairs, as well as to the fulvous underfur. In specimens with a yellowish cast to the nose it is found that only the extreme tips of the hairs are white, all of the subapical portions being fulvous, passing at the extreme base into dusky. Often in specimens with very white heads the underfur is mostly dusky. In spring the ears lose their winter covering very irregularly, it being sometimes shed very early in the molt, and sometimes remaining till the summer pelage is well developed over the whole body.

Unfortunately there are no specimens at hand representing the partial change to white supposed to frequently occur at southern points in the habitat of this species, and is known to be the case in *Lepus campestris*. Reasoning, however, from analogy, and from the condition of the specimens just described, there is no ground for supposing the lack of complete change in color to be due to an imperfect autumnal molt, but rather to the fact that the new hair comes out largely of some other color than white.

Whether or not the soft underfur is also shed in autumn cannot readily be determined, but from its increased length and abundance in winter, as compared with summer and early autumn, it is evident that if not wholly renewed it at least is very greatly augmented.

In the case of the spring molt, there is little doubt that the whole pelage is renewed, the underfur quite as completely as the overhair.

In the case of wounds from fighting or other cause, resulting in the violent removal of large bunches of fur, it is interesting to note that in the autumn the new hair comes out white, often weeks in advance of the general change, and that in spring, under similar circumstances, the hair comes out brown, like the summer coat, much in advance of the general change from winter to summer pelage.

Conclusions.

From the foregoing it is evident (1) that the change of color, both in autumn and in the spring, is due to a change of pelage, and not, even in the fall, to a change of color in the hair itself. (2) Further, that this change is gradual, occupying many weeks, both in fall and spring; and that while it may be doubtless more or less accelerated or retarded by temporary climatic conditions, it is not intimately connected with phases of weather, but is as regularly periodic as the seasons themselves.

(3) That the method of change, as regards the parts first affected, is the reverse in spring of the order characterizing the autumnal change: in the fall the change beginning with the feet and ears, the sides of the nose and front of the head, which often become radically changed before the body is much affected; while as regards the body, the change begins first at the base of the tail and extreme posterior part of the back, and at the ventral border of the sides of the body, working thence upward toward the median line of the back and from behind anteriorly, the crown of the head and a narrow median line over the shoulders and front part of the back being the parts last changed. In the spring the order of change *is exactly the reverse*, the molt beginning on the head and along the median line of the anterior half of the dorsal region, extending laterally and gradually to the ventral border of the sides of the body and posteriorly to the rump, and then later to the ears and down the limbs to the feet, which are the parts last affected, and which often remain but little changed till the head and body have pretty completely assumed the summer dress.

(4) That for some time during the early part of the spring molt, after the white overhair has been shed (except for a few

scattered hairs), the pelage consists chiefly of the heavy coat of soft winter underfur; later this gradually disappears, probably partly by wearing off and partly by falling out, as the summer coat thickens and matures.

(5) That in spring the molt occurs quite as early and proceeds just as rapidly (if not a little more so) in the females as in the males, and that the molt is practically completed before the young are born.[1] This is noteworthy as being just the reverse of what occurs in many of the Sciuridæ, especially in the genera *Sciurus* and *Tamias*,[2] in which the males molt much earlier than the females, the molt in the latter being delayed not only till after the young are born but till near the close of the nursing period.

History of the Subject.

More than a century ago, Thomas Pennant, a most astute naturalist for his time, gave the gist of the whole subject in a short paragraph of five lines, as follows: "From *Hudson's Bay*, as low as *New England*, these animals, at approach of winter, receive a new coat, which consists of a multitude of long white hairs, twice as long as the summer fur, which still remains. About the middle of *April* they begin to shed their winter covering."[3] Omitting the last clause of the first sentence, we have the whole case well stated. Later writers, however, conjectured another cause for the autumnal change. Thus, Dr. Richardson (afterwards Sir John Richardson) believed "that the change to the winter dress takes place by a lengthening and blanching of the summer fur."[4] This view appears to have been widely entertained by both scientific and non-scientific writers. But no one appears to have made any attempt at a thoroughly scientific investigation of the matter prior to 1869, when Assistant Surgeon Francis H. Welch published an elaborate paper on the subject.[5]

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[1] Judging by the condition of the embryos in females taken late in April, when the change to summer pelage is well advanced.

[2] See this Bulletin, Vol. III, pp. 42, 44 and 49, 50.

[3] Arctic Zoölogy, Vol. I, 1784, p. 96.

[4] Fauna Boreali-Americana, Vol. I, 1829, p. 218.

[5] 'Observations on *Lepus americanus*, especially with reference to the Modifications in the Fur consequent on the rotation of the Seasons, and the Change of Colour on the advent of Winter; based on Specimens obtained in the province of New Brunswick, North America.' By Francis H. Welch, Assistant Surgeon, 1st Battalion, 22d Regiment. <Proc. Zoöl. Soc. London. 1869, pp. 228-236.

Unfortunately it consists of a singular mixture of truth and error, although looked upon as authoritative by subsequent writers. In fact, it is difficult to understand how the author could have been so misled, or could have been so unfortunate in his observations. His detailed statements as to the change in color, so far as its gradual progress is concerned, leave little to be desired, but in accounting for the change, or in attempting to explain the cause and manner of the change, it is evident at once that his observations were faulty and superficial, notwithstanding his apparently extensive use of the microscope in his investigations.

He says: "About the commencement of October the first indications of the hybernal change are to be detected: the nose and lips assume an iron-grey hue, from the presence of white hairs; many of the whiskers are white at the tip or some portion of the shaft; a patch of white hairs, twenty to thirty in number, of the size of a split-pea, forms on the centre of the forehead; white hairs become apparent on the edges of the ears outside and at their junction with the neck, while on the inside a crop of downy white fluff springs up; a few of the longer hairs of the pile of the back, especially towards the tail, are observed to be blanched wholly, or only at the tips, while the greater part of the smaller kind are brown at the tip, with the tawny band of the shaft much lighter in color or even white; the anterior surface of the feet, especially of the hind ones, is mottled with white. Thus far," he continues, "the most careful examination fails to elicit any addition to the autumnal coat, the change being superficial and entirely dependent on an alteration of colour in existent hairs."

With the material at present before me it is hard to understand how such a conclusion could have been reached. The only explanation that suggests itself is that specimens were casually examined from time to time in the flesh and not preserved for detailed study and comparison in series. For later on he appears to have discovered the new growth of hair, for he says: "During November this surface-change gradually deepens in intensity, ...and is accompanied by a deeper one of a much more potent character; for on separating the fur a thick crop of white stiff hairs (first apparent at the root of the tail) is to be detected springing up over the back and sides. These hairs, at first extremely minute and entirely of a new growth, rapidly increase in length, accompanied by an advance in the superficial changes above mentioned; soon they are on an equality with the pile of the autumnal coat on the sides, forming a mottled whity-brown band from ears to tail, contrasting strongly with the centre of the back, at present comparatively unchanged; anon they outstrip this, reducing the mottling on the sides to a pure white, and, gradually implicating the centre of the back in the same process ....they clothe the animal in a thick white outer garment, generally assumed about the first week of December. As soon as the new growth renders itself superficially evident, the change of colour in the old hair, which on the back up to this time has been slow in progress, advances with great rapidity, so that in a few days only a few coloured hairs, generally remaining unchanged throughout the whole winter, can be detected" (l. c., pp. 230, 231).

Later on he says: "Thus the winter hue would appear to be brought about by a change of colour in the pile of the autumnal coat combined with a new hybernal white crop, the latter undoubtedly playing no small part in the colouring process and in the thickening of the fur. *There is no indication of shedding.*[1] An increase in length ensues over the whole body....The process may be summed up as a combination of colour-change (except in the underparts) of the lengthened outer hairs of the autumnal [=summer] coat, with an additional hybernal growth; the former universal over the body, *the latter limited to certain portions*"[1] (l. c., p. 232).

There is so much to be corrected in the foregoing quotations that the points may best be taken *seriatim*.

(1.) First, as to the whiskers, which elsewhere, it is said, "will demonstrate each variety" of the "blanching process" of the hairs. My series of over seventy specimens shows that the color of the whiskers is entirely independent of any seasonal color-change of the general pelage. They may be either all black, as in many of the midwinter specimens, as well as in some

[1] Not italicized in the original.

October and November specimens; or part white and part black, or even the same hair particolored, as happens about equally in early fall specimens and in December, January and March specimens. This feature appears to be a matter of purely individual variation, having no relation to season.

(2.) Secondly, the small white spot in the forehead. This is a mark more or less common to all species of Leporidæ, including those that do not change to a white winter dress. It varies in extent from three or four white hairs to much more than "twenty to thirty." It is especially frequent in *Lepus americanus* while in the *summer coat.* It is present in 10 out of 18 fall specimens now before me, in which the crown is unchanged by molt, and also in a large proportion of the April and May specimens in which the head has acquired the full summer dress. Being found all summer, and more or less commonly in all Hares, it evidently is not one of the early stages of change to the winter coat, either by a "blanching process," or any other.

(3.) As already said, the failure to discover a new growth of white hair about the nose, sides of the head, and on the ears and feet, must have been due to faulty observation, since my specimens demonstrate its presence beyond question. Some show it so plainly that it is impossible not to recognize it on the most hasty inspection; in others the fact that the short white hair is a new growth is not so obvious, so that a mistaken interpretation of the facts might easily be made by one unaware that the absence of a new growth would be an anomaly, and in opposition to what occurs as a rule in mammals. Besides, as already shown, the pelage of the sides of the nose, the feet, and sometimes of the greater part of the head, is often, even in midwinter, only superficially white, even the coarser hairs being only tipped with white, easily leading to the inference that they were undergoing a "blanching process." This erroneous departure has obviously influenced the author's whole subsequent work, which his discovery later on of the new growth, when more advanced, failed to correct, and led to the false assumption that the change of color over the whole body was due largely to the blanching of the old hair.

(4.) It is assumed that the old hair is *not shed*, but suddenly assumes new vitality and proceeds to "increase in length," and to take on an entirely changed molecular structure, for he says elsewhere (l. c., p. 233) that "to this [increase in the length of the autumnal hairs] must be added that the blanching shaft, in the majority of cases, has also augmented in thickness....the increase being consequent upon a more than usual number of series of cells entering into its composition." And again (l. c., p. 234): "It would seem that the rapid development of new hairs .... involves the autumnal outer fur in the same process, leading to an increased length and thickness in the shaft of the hair by the superposition of layers of the same colourless cells entering into the structure of the new growth—perhaps combined also with an arrested production of pigmentary matter." This is further elaborated in such detail of explanation, based on microscopical examinations, that it would seem to rest on a solid basis, but I must confess that to me the case is simply incomprehensible. My material certainly demonstrates that the summer coat is shed, and not transformed, either in structure or color. On the other hand, it does not need even the aid of a magnifying glass to show that the winter coat of long white overhair is of a finer and softer texture, with a much smaller (instead of larger) diameter of shaft than the summer coat, which is coarser, harsher to the touch, and of a different structure, the particolored (not the wholly black to the same degree) hairs of the summer coat being subapically thickened, the thickened portion including the fawn-colored band, and extending slightly above and below it. Hence, the only explanation that occurs to me is that the thickened hairs were a part of the old summer coat, which it was assumed were in process of change, or about to change to white, simply from the fact that the brown hairs were disappearing, and that he compared these old hairs with the new hairs of the winter coat. Again, in specimens well advanced in change, on casually parting the pelage of the back, the new white hairs are so abundant and conspicuous that all of the hairs seem white below the surface, but on removing some of the hairs still remaining of the summer coat they are found to be colored to the base and still unchanged.

In a January specimen (No. 3277, Rutland, Vt., Jan. 8) a small proportion of the hairs over the dorsal region are pure white for rather more than their apical half, and then pass into a broad band of very pale horn-color, which usually fades out basally, or may persist faintly to the base of the hairs. In texture and size they do not differ from the pure white hairs with which they are intermixed. A very few of these basally faintly horn-tinted hairs can be found in another specimen taken at the same time and place, and in one out of three early March (March 2) specimens from the same locality. Also a specimen from Locust Grove, Lewis Co., N. Y., taken March 21, 1884, and kindly loaned me by Dr. Merriam, is a fine example of this phase of coloration. In this specimen many hairs still remain wholly black, others are only black, or more or less blackish, basally. These hairs are evidently, however, in each case, a part of the true winter coat, and not a remnant of the summer coat, any more than are the fulvous hairs on the fore legs and hind feet of certain midwinter specimens, or the basally fulvous hairs on the nose, or the fulvous hairs on the ears, of these same specimens. They simply grew particolored instead of white, and have not either the texture or the form of the particolored hairs of the summer coat. Yet, although so exceptional, they might, considered alone, seem to give some support to the 'blanching' theory of the autumnal change of color.

So much attention would not be given, in this connection, to Mr. Welch's paper, in view of the overwhelming evidence of its erroneous character, were it not that it has recently been made prominent by Mr. E. B. Poulton as the chief basis for his theory respecting 'Variable Protective Resemblance in Vertetrates,'[1] in which he either quotes at length or summarizes from Mr. Welch most of the passages above quoted, and proceeds to theorize from this insecure basis.

In conclusion it may be well to correct a time-honored error respecting the geographical distribution of *Lepus americanus*, since it figures prominently in the matter of seasonal change of color. Thus Mr. Poulton (l. c., p. 97), in speaking of this species, says: "In Hudson's Bay Territory it changes early and carries the winter coat till June, while no change of colour takes place

[1] *Cf.* 'The Colours of Animals,' Chap. VII. Intern. Sci. Ser., Vol. LXVII. New York, Appleton & Co., 1890.

in the winter in the *southern parts of the United States*,"[1] basing the statement probably on Welch (l. c., p. 235), who in turn quotes it directly from Sir John Richardson. Richardson seems to have derived the statement from Pennant, as he says (Faun. Bor.-Am., I, p. 218): "The white color is less perfect in more southern districts, and to the southward of New England, according to Pennant, the brown dress endures all the year." Pennant, in his 'Arctic Zoölogy,' recognized only two species of North American Hares—the Varying Hare and the American Hare. The first is the Arctic Hare of the present day; the other was primarily the Varying Hare here under consideration, but included also all other species of North American Hares then known. Hence when he says, "From *New England* southward they retain their brown color the whole year," he is evidently speaking of the 'Cotton-tails' and Swamp Hares of the South, which, as every one knows, never turn white. It is needless to tell intelligent mammalogists that the southern limit of distribution of the Varying Hare is the southern half of the Alleghanian Fauna—in other words, it is not found at ordinary levels south of Massachusetts. Furthermore, there is little evidence to show that it does not practically become white in winter to the very southern limit of its range, although less perfectly so than further north, the change in color sometimes remaining more or less incomplete and superficial, so far as can be determined at this writing.

[1] Not italicized in the original.

Article V.—OSTEOLOGY OF PATRIOFELIS, A MIDDLE EOCENE CREODONT.

By J. L. Wortman, M.D.

Plate I.

History and Synonomy.

The genus *Patriofelis* was originally established by Dr. Leidy, in the 'Proceedings' of the Philadelphia Academy, March, 1870, p. 10, upon the fragmentary portions of the rami of both lower jaws, which were obtained by Dr. Hayden in the Bridger Baisin, Wyoming, the year previous. In August, 1872, Prof. Marsh described (Amer. Jour. Science, Vol. IV, p. 10) from the same locality, some remains of a "gigantic Carnivore" which he referred to a new genus and species under the name of *Limnofelis ferox*. According to Prof. Marsh's statement, his specimen consists of portions of the skull, fragments of the lower jaw, some vertebræ, and other less important parts of the skeleton. In the same paper he describes a second species under the name of *Limnofelis latidens*, from a last upper premolar, which was obtained in the same horizon. Prof. Cope, in the 'American Naturalist' of 1880 (Vol. XIV, p. 745), proposed a third genus from teeth and limb bones, which were collected by the writer in the Wind River Baisin in the summer of 1879. To these remains Prof. Cope gave the name *Protopsalis tigrinus*. Prof. Scott has described in the 'Journal of the Philadelphia Academy,' 1886 (Vol. IX, p. 174), some remains of a large Creodont from the Bridger formation, which he referred to Prof. Cope's genus *Protopsalis*. A new species of this genus was proposed by the writer (Bull. Amer. Mus. Nat. Hist., Vol. IV, p. 98, 1892), under the name of *P. leidyanus*, from a specimen in the Princeton Collection.

The material collected by the American Museum Expedition into the Bridger Baisin now enables me not only to give an unusually full description of the osteology of the species of

Patriofelis, but to establish the synonomy of the three generic names that have been proposed.

A careful comparison of Marsh's description of *Limnofelis ferox* with Prof. Cope's figures and description of *Protopsalis tigrinus* leaves little doubt of the generic identity of the two specimens. Both of them, moreover, agree so perfectly with our specimens, that I do not hesitate to refer them to the same genus. Marsh's description is characteristically brief and imperfect, but enough is stated to indicate that the last lower molar of *Limnofelis* is the same as that of *Protopsalis*, which is in turn like that of *Patriofelis*. Marsh's specific name *ferox* is therefore adopted, since it has priority. A comparison of our specimens with Leidy's type of *Patriofelis ulta* reveals a difference only in size, our largest specimen being at least one-third larger in every way. I am therefore convinced that *Limnofelis* and *Protopsalis* do not present any characters, so far as known, which will enable one to separate them generically from the genus originally proposed by Leidy, namely, *Patriofelis*.

The specimens upon which this paper is based were found in the Bridger Baisin at widely separated localities. The most complete is from the Henry's Fork region; several other specimens of both the species were found at Twin Buttes, and their remains are likely to occur wherever the exposures contain fossils. The larger species, *P. ferox*, is one of the largest Creodonts known, and equaled in size a full-grown black bear. The head was disproportionately large and massive, almost equaling in this respect an adult lion. The smaller species, *P. ulta*, was about one-third smaller. In both, there was a long and powerful tail, broad plantigrade feet, which, together with other characters presently to be considered, lead to the conclusion that they were aquatic in habit.

The subject is considered under the following heads: *History and Synonomy; Osteology; Comparison with other Creodonts; Comparison with the Seals; Probable Habits; Classification and Species.*

I.—Osteology.

Materials for Description.—The most important specimen in our collection, pertaining to the larger species, consists of an almost complete skeleton remarkably well preserved. The skull and lower jaws are present, but unfortunately somewhat damaged. The teeth are mostly wanting, but in the lower jaw the fangs of the entire series are preserved, so that their number can be determined. The facial part of the cranium is, moreover, considerably damaged, but at least two of the upper molars are sufficiently preserved to admit of a determination of their structure. With the exception of some of the cervicals and the first two or three dorsals, the vertebral column is complete and well preserved. Nearly all the ribs of one side are present, as are also a number of the sternebræ. The fore limb is represented by a scapula, part of a humerus, ulna, and radius, and nearly all the manus. The pelvis is wanting, but both hind limbs are well nigh complete. In a second specimen, somewhat smaller, one ramus of the lower jaw, bearing the premolars and a damaged first molar, is present, together with many important parts of the limbs. A third specimen includes a part of the hind foot with the greater part of the pelvis. A fourth specimen contains the pelvis, hind feet, vertebræ, humerus, scapula, ulna, radius, and part of the fore foot.

Skull.—The single skull of *Patriofelis* contained in the collection is considerably damaged. When found it had already been weathered out of its matrix, and consisted of a heap of fragments. These, after much labor, have been put together and the result is a fairly satisfactory skull. Of this the posterior part, including the condyles, occiput, mastoid processes, brain-case, glenoid cavities and the zygomatic arches, is tolerably perfect. The greater portion of the top of the skull is also preserved, including both postorbital processes with the divergent roots of the sagittal crest posteriorly almost to the point of their junction, together with the greater part of the right nasal bone to its anterior free extremity. There is also a part of the left maxillary, reaching from its point of junction with the frontal forwards and downwards in front of the infraorbital foramen, so as to include the roots of the first two premolars and the posterior wall of the left canine alveolus. The anterior portions of the zygomatic arches, moreover, have attached to them the posterior parts of the maxillaries, which, upon the left side, contain the last molar in position with the roots of the one immediately in advance of it. The posterior termination of the infraorbital is also indicated. There is in addition to the parts already mentioned the right anterior wall of the anterior nares, showing the alveoli of the canine, together with the lateral incisor, that is not connected by actual contact with the rest of the facial bones.

I have thus described at length the pieces as they actually exist for the reason that there is a possible source of error in the construction of the face. The top of the skull is not connected by contact with the rest of the bones, and it may be placed too far forwards; but taking into consideration the sweep of the divergent branches of the sagittal crest, the position of the post-orbital processes, as well as other points, I am led to believe that it is approximately correct. The whole skull as thus restored is remarkable for its large size and general robustness as compared with the rest of the skeleton. Its size is quite equal to that of a lion, while the size of the body is but little if any larger than that of a black bear. The face is extremely short and broad, with high, wide anterior nares. Behind the postorbital processes the

Fig. 1. *Patriofelis ferox.* Skull from above, ¼ natural size.

skull is much constricted, as in the seals, and there is a correspondingly long interval between the postorbitals and the anterior termination of the brain cavity. The sagittal crest is unusually high and prominent, and is continued far in advance of the brain cavity, as in the sea-lion ; it terminates posteriorly in a comparatively narrow, massive, overhanging occiput. Just above the posterior roots of the zygomatic arches at the base of the sagittal crest are seen two large postparietal foramina, which lead downwards into the lateral sinuses.

The zygomatic arches are remarkably heavy and widely expanded. The glenoid cavities have great lateral extent, and are provided with anterior and posterior glenoid processes, as in many of the fissiped Carnivora and the sea-lion. The mastoids are large and prominent ; the paroccipitals are conspicuous and closely applied to them. The tympanic bullæ are not preserved. The basioccipital is relatively broad and deeply marked for muscular insertion. The condyles are small in proportion to the size of the skull, and the foramen magnum is higher than it is wide, as in the seals. The occiput is relatively narrow, of great vertical extent and overhangs the condyles, as in the feline skull.

The *foramina* cannot be determined with a great deal of satisfaction, but some of them are sufficiently preserved to admit of

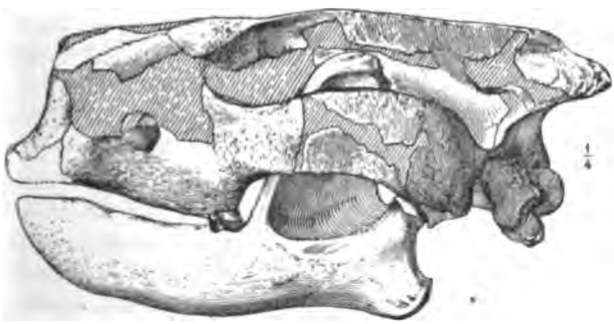


Fig. 2. *Patriofelis ferox.* Skull from side, ¼ natural size.

description. The optic foramina cannot be made out, but there is a distinct sphenoidal fissure, which is apparently not confluent with the foramen rotundum, as it is in the sea-lion. A very distinct and well-marked groove extends from the opening of the foramen ovale, forwards to the opening of the foramen rotundum, and undoubtedly indicates the presence of an alisphenoid canal. The presence of a foramen lacerum medium cannot be determined, but a deep groove in the side of the basioccipital represents a large carotid canal, which would be completed were the tympanic bullæ in position. The region of the posterior lacerated and condyloid foramina is too much broken to show them distinctly. There are no post glenoid foramina. The stylomastoid has its usual position, and forms a deep groove between the mastoid and paroccipital process. There is another foramen of considerable size which opens backwards and downwards upon the posterior wall of this process. This foramen appears to be peculiar, and is not represented in any of the modern Carnivores.

The *brain-case* is very small in proportion to the size of the skull. While the skull is considerably larger than that of the sea-lion, the actual capacity of the cranial cavity is less than one-third as great. Its walls are remarkably thick. The cerebellum was entirely uncovered by the cerebral lobes, and the tentorium was very little, if any, ossified. The cerebral cavity shows that there were at least two longitudinal or suprasylvian convolutions, much as in the more primitive carnivorous brain. There is no satisfactory evidence of a crucial sulcus. The cerebellum was relatively large, and the walls of its cavity are unusally thick. The roof is marked by a deep longitudinal furrow for the lodgment of the vermis of the cerebellum.

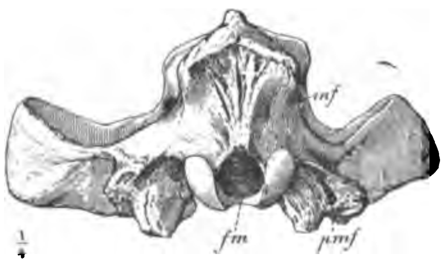


Fig. 3. *Patriofelis ferox.* Skull, occipital view, ¼ natural size.

The *lower jaw* partakes of the nature of the skull, and is remarkably heavy and robust. The horizontal rami are short and deep. The symphysis is rather short, and the chin abruptly rounded. The last molar is placed close against the base of the coronoid process, which rises rapidly and does not overhang the condyle. The masseteric fossa is wide and deep ; the condyles, which are placed low, have great transverse extent and a scroll-like pattern, as in the cats. The angle is well rounded and little produced, as in *Oxyæna*. The inferior dental canal is large and situated below the level of the tooth line. The inferior border of the jaw is nearly straight.

The *dentition* is but very little known, and our material does not, unfortunately, throw very much light on the subject. From Leidy's type specimen of *P. ulta* the number of molars and premolars in the lower jaw was determined to be five, of which three have been considered Pms. and two Ms. There were either four or five teeth in the upper jaw belonging to this series. I am inclined to the opinion that there were only four, of which three were Pms. and one M. Although the roots of the first two premolars above are preserved in the fragment of maxillary attached to the skull, it is difficult to determine whether the first one was single or double rooted. Now in *Oxyæna* there are four Pms. and two Ms. in the upper jaw, of which the first Pm. is single rooted and the last M. is transverse to the long axis of the jaw. In *Patriofelis* the last tooth is not transverse, and if *Patriofelis* is descended from *Oxyæna* directly, which I think the evidence demonstrates beyond question, the last upper tooth of *Patriofelis* must represent a single molar, since it would have been manifestly impossible for the transverse tooth to become again longitudinal. The transverse position is the first step in its disappearance. In the same way it may be determined that if the first Pm. is single rooted it represents the first Pm. of *Oxyæna*, and if two rooted it represents the second Pm., in which case there would therefore be only four teeth behind the canine. In our specimen it has the appearance of being two rooted, and I therefore consider the formula to be I. $\frac{3}{2}$,(?) C. $\frac{1}{1}$, Pm. $\frac{3}{3}$, M. $\frac{1}{2}$.

The structure of the last upper tooth of *Patriofelis* is not distinctly shown in our specimen on account of the extreme wear of the crown; enough is preserved, however, to show that it had a well-developed sectorial structure. The para- and metacones are apparently completely fused so as to form an anterior blade, the posterior blade being furnished by the prolongation of the heel, as in *Oxyæna* and *Hyænodon*. If there were an internal cusp in the unworn tooth it must have been small. There is another upper tooth in the collection from another individual, which I take to be either a first molar or the last premolar. It repeats the structure of the tooth just described, with the exception that the anterior blade is relatively larger. It has three roots, of which two are anterior and one posterior, and the internal cusp was rudimentary or wanting. The structure of the anterior teeth is entirely unknown. The canines were large and powerful, and there were probably three incisors above. The outer one, judging from its alveolus, was considerably enlarged.

A fragmentary specimen of a lower jaw in our collection shows that there were but two pairs of incisors below. These are crowded in such a way that the median one has a position almost immediately in advance of the outer one; the canine was large and slightly compressed laterally. The anterior (second?) premolar is placed very obliquely to the tooth line; it has a simple crown and two roots. The third is likewise two rooted, but the crown is not preserved. The fourth premolar is the largest of the series; its crown consists of a single principal cone, to which are added an anterior and posterior basal cusp. Of these the posterior or talon is the larger, and there is some indication of a second small internal cusp to this part of the tooth; this is suggested by the breadth and thickness of the talon at its base; it is shown in Leidy's type of *P. ulta*. The crown of the first lower molar is broken beyond recognition, but if we are to judge from Cope's specimen from the Wind River, as well as from Leidy's type, it has a structure very similar to the corresponding tooth of *Oxyæna*, with a more reduced talon. The last molar of the lower series is not preserved in any of our specimens. It has, however, been described by Marsh, and agrees so perfectly with the tooth figured by Cope, as well as that of Leidy's type, that its structure may be regarded as fully determined. The whole tooth bears a striking resemblance to the sectorial of the cat.

VERTEBRÆ, RIBS, AND STERNUM.—Almost the entire vertebral column is preserved in our best specimen of *Patriofelis*. Counting from the sacrum forwards there were sixteen vertebræ in position, so that there is no chance for error as regards this much of the dorso-lumbar series. Of this number six are lumbar and the remaining ten are dorsal. As there are thirteen ribs of one side present in this same specimen, it is evident that there are at least three dorsals missing. I have therefore added these three vertebræ from another individual. There may have been one or two more, but I am led to believe that the number thirteen is approximately correct. This is the number usually found in the cats, but in the seals there are fifteen, and in the sea-otter there are fourteen dorsals.

The Atlas.—The general form of the atlas more nearly resembles that of the felines than any other of the existing Carnivora. This is especially seen in its vertical flattening, in marked contrast with the high arch and great vertical diameter of the neural canal of the sea-lion and sea-otter. Although the transverse processes are somewhat damaged in the single specimen which we possess, yet it is evident that they had a considerable lateral expansion, and are placed relatively high up on the sides of the bone, as in the cat, and not at its base, as in the sea-lion and sea-otter. In many of the Carnivora the transverse processes have a very marked backward direction, but this does not seem to have been the case in *Patriofelis.* There is a strong ridge occupying the upper anterior surface of the transverse process, which, so far as I am at present aware, is peculiar to *Patriofelis.*

The way in which the vertebral artery pierces the transverse process of the atlas in the different groups of the Carnivora is subject to considerable variation, as well as the form and direction of the transverse processes themselves, and in some of them, at least, these features are highly characteristic. In all of the Felidæ which I have had the opportunity of studying, the canal pierces the transverse process at its extreme posterior edge, where it is thickened and joins the body of the bone. The superior edge of this posterior border slightly overhangs the inferior edge. The process itself, moreover, in its fore and aft extension, is more or less parallel with the long axis of the neural canal. This character appears to be very constant in the Felidæ, and so far as we know the structure of the atlas in the more generalized Nimravidæ, it is true of them also. In the Canidæ, upon the other hand, the foramen for the vertebral artery is situated well in advance of the posterior border of the process, and instead of having a fore and aft direction, as in the cat, pierces the process almost vertically from above. In the Viverridæ and Hyænidæ the position of the foramen is very much as in the cats. There is, however, an important difference between these two families and the felines in the character of the canal where the artery enters the suboccipital foramen in the anterior part of the atlas. The difference consists in the formation of a bony bridge in this situation which gives to the suboccipital foramen a double opening in the hyænas and civets, whereas it is single in the cats. It is interesting to note, however, that in *Haplophoneus* the sub-occipital foramen has a double opening, as in the Viverridæ and Hyænidæ. Among the bears and mustelines, the lower edge of the posterior border of the process is extended backwards considerably, and the upper surface of the process is marked by a strong ridge. This ridge corresponds to the superior lip of the posterior border of the transverse process in the cat. In the more typical seals the vertebral foramen is greatly enlarged, while in the sea-lion it is of more normal proportions, and its arrangement, as well as that of the transverse process, is very much as in the bears.

The *axis* does not offer any characters of unusual importance. The neural spine is large and overhangs the posterior zygapophyses, very much as in the cats. The centrum is circular in section at its posterior extremity, and not depressed and oval as in the cat. Upon its inferior surface the centrum exhibits a strong keel, much more pronounced than in any of the modern Carnivores. The odontoid process is missing.

In the succeeding cervical vertebræ the centra are convex in front and concave behind. They present a circular section at their extremities, and are strongly keeled beneath. The neural spine of the sixth cervical is preserved, and indicates a proportionately greater height than is seen in any of the cats. The transverse processes are not sufficiently preserved to admit of description.

The *dorsals*, as already stated, are very probably thirteen in number, and in the anterior part of the region have relatively small bodies, with well-marked convex surfaces in front and concave faces behind. This convexity and concavity gradually decreases towards the posterior part of the region until in the lumbars the central faces are nearly plane. In a like manner the centra increase rapidly in size posteriorly. The neural spines are not preserved, and their relative lengths cannot be determined, but judging from their roots they are relatively high and strong, as in the cats. The anterior and posterior zygapophyses are flattened oval facets which are directed upwards and downwards in the anterior ten of the series. The postzygapophyses of the tenth, however, become abruptly rounded or cylindrical, and are received into corresponding grooves in the succeeding vertebra. In the remaining dorsals, as well as the lumbar series, these articular processes become further complicated by the formation of a double tongue and groove, a character which, so far as I am now aware, is not found in any other carnivorous or creodont mammal. In the postzygapophyses the groove is superior and the cylindrical part inferior, while in the anterior zygapophyses this order is reversed. At the point where the zygapophyses change their character so abruptly, metapophyses and anapophyses appear and are well developed from this backwards. It is moreover at this point that the transverse process for the articulation of the tuberculum of the rib disappears, and the neural spine changes from a backward to a forward direction.

The *lumbars*, six in number, have large plane-faced centra, with a strongly developed inferior keel, which gives to them a somewhat trihedral form. The neural spines are strong and unusually broad, especially those of the last three vertebræ. The distal ends of the spines of the anterior three vertebræ are more or less thickened and tuberous. All the lumbars have well-developed transverse processes, as well as anapophyses and metapophyses.

The *sacrum* is made up of three vertebræ, of which two unite with the ilia at the sacro-iliac synchondrosis. The bone is relatively broad and heavy, in keeping with the large size of the lumbars in advance of it, and the powerful tail behind. The neural spines are present, although smaller in every way than those of the lumbar series.

The *tail* is well nigh complete, and consists of twenty-eight caudals. The proximal ones are large and strong, with well-developed transverse processes and complete articular processes. The neural canal and articular processes cease at the tenth from the sacrum, after which they present the pattern usually seen in the caudal region of the long-tailed Carnivora. There were numerous chevron bones, but none of them have been preserved.

The Ribs.—As already remarked there are thirteen ribs of one side preserved, together with numerous fragments of those of the other side. As this number agrees so well with the number of dorsals I am persuaded to believe that there cannot have been more than one or two pairs more than this number at the very utmost. The first rib is somewhat remarkable for its shortness and stoutness, together with the unusual size of its articular processes. It is considerably flattened, as are the succeeding three, after which they become more and more rounded. The last three have no tubercula, and articulate directly with the bodies of the dorsals.

The Sternebræ.—There are six sternal bones preserved in the more complete skeleton. These resemble the corresponding bones of the sea-lion more than those of the felines in their relative robustness and greater breadth. They are moreover much shorter than in any of the fissiped Carnivora.

Fore Limb.—The fore limb of *Patriofelis* differs materially from that of the fissiped Carnivora in the proportions of the various segments. The scapula, humerus, and ulna are of about equal length, while the radius and manus also compare very closely in this respect. In the fissiped Carnivora, on the other hand, the scapula is very generally shorter than either the humerus or ulna, the length of the ulna equals, or may exceed that of the humerus, and the length of the radius is always greater than that of the manus. In the Pinnipedia the proportionate lengths of the component segments are again different. The scapula is always longer than the humerus, the ulna is longer than the scapula, and the manus is again longer than the ulna. One of the chief peculiarities of the fore limb of the seal consists in the enlargement of the scapula and the elongation of the manus. In this respect, therefore, the fore limb of *Patriofelis* is more like that of the seals than the land Carnivores.

The *scapula* is relatively longer and broader than that of the cats, dogs, or bears. The prominent spine divides the external surface in such a manner that the greatest breadth of the two fossæ are about equal, whereas the greatest breadth of the infra-spinous fossa in the cat, dog and bear, always exceeds that of the supra-spinus fossa. In the Otariidæ, at least among the seals, it is the supra-spinous which is the larger.

The head of the scapula presents a rather shallow pyriform glenoid cavity, and is joined to the body of the bone by an exceedingly short neck. As a result of this arrangement the acromion, which is unusually large, overhangs the shoulder joint to a greater extent than is seen in any of the recent genera. The tubercle for the attachment of the long head of the biceps is well developed, and occupies its usual position on the dorsal or external portion of the neck on the coracoid side. The coracoid process is of moderate proportions, and is rather obtuse, as in the bears and dogs, differing in this respect from the cats, in which it is produced and pointed. On the axillary border, at the point of junction of the head with the body, is seen a well-marked roughened depression for the tendinous origin of a part of the *teres minor*. The spine is large and prominent, and is terminated proximally by a remarkably well-developed acromion. To this is added a large overhanging metacromion, whose dimensions greatly exceed that of the feline scapula, in which it is best developed of all the Carnivora. The glenoid or axillary border is thickened and raised above the general level of the infra-spinous fossa, and towards its posterior termination shows a relatively small though distinct area for the origin of the *teres major*. This area is unusually large in the bears and seals.

The *humerus* is remarkable for the enormous development of the deltoid crest, the great prominence of the supinator ridge, as well as the lateral flattening of the shaft. The bone is relatively short and robust, not exceeding the scapula or ulna in length, and the shaft is moderately bent. The head is small, laterally compressed, and its articular surface is prolonged backwards so as to overhang the posterior border of the shaft to an unusual degree.

The bicipital groove is single, deep and narrow, the tuberosities are quite prominent and robust, and are deeply marked for ligamentous attachment. The greater tuberosity rises above the level of the articular surface, and is somewhat compressed from side to side, having a very slightly oblique direction to the long axis of the head. This is more pronounced in the cat, and becomes almost transverse in the sea-lion. The deltoid crest is almost as prominent as it is in the sea-lion, and occupies at least five-eighths of the entire length of the bone. In this particular the humerus differs markedly from that of all the land Carnivora and approaches that of the seal. The distal portion of the bone shows a powerful supinator ridge, and deep and well-marked anticubital and anconeal fossæ. There is apparently no supertrochlear foramen, but a large entepicondylar foramen is present. The trochlea is relatively broad, and the outer margin is thin and produced downward almost as far as the inner border. The anterior face of the articular surface is convex on the outer side, and is received into the cup-shaped head of the radius. It is not so convex as in the cat but is more like that of the sea-lion. A large part of the trochlea is occupied by the head of the radius, so that pronation and supination must have been somewhat limited.

The *ulna* is a strong bone, and is remarkable chiefly for the length of its olecranon process. In this respect it exceeds any of the modern Carnivora. In the dog and black bear the olecranon is only about 10½ per cent. of the entire length of the ulna; in the puma it is about 12½ per cent.; in the sea-lion it is about 17½ per cent.; while in *Patriofelis* it is nearly 24½ per cent. The posterior wall of the sigmoid cavity is elevated more than is usual in the Carnivora, as is also the case with the coronoid process. The shaft is laterally flattened and deeply grooved upon the outside. There is also a shallower groove found upon the inside. The shaft is deepest at the coronoid process by reason of a considerable backward curve, which it makes in this situation. The distal end is fashioned into a short, though stout, styloid process which articulates with the cuneiforme.

The *radius* is short and robust. Its head is oval in section, and covers a large part of the humeral trochlea. It is probable that the movements of pronation and supination were more or less limited. The distal end of the bone is considerably expanded, but it does not exhibit the deep tendinal sulci which are seen in the modern Fissipedia. In this respect it is more like that of the sea-lion. It also shows a tendency towards the distal flattening of the shaft, a feature so conspicuous in the radius of the sea-lion. The distal articular surface is relatively small, and does not show separate facets for scaphoid or lunar, as one would be led to infer.

The Manus.—The carpus of *Patriofelis* is like that of the other Creodonta, in that the scaphoid, lunar and centrale are free. The *scaphoid* has about the same proportions and the general form of that of the cat, if the lunar and centrale were removed. Proximally it shows a single convex facet for articulation with the radius. Laterally it is applied very closely to the lunare by a nearly vertical facet, the proximal surface of the two bones forming a continuous convex surface. It is owing to this fact that the distal articular surface of the radius exhibits but a single facet. Distally but two facets can be distinguished, one for the trapezium, and another for the trapezoid and centrale. That for the trapezium is the larger of the two, in consequence of the abnormally large size of this latter bone.

Fig. 4. *Patriofelis ferox*. Right manus, ½ natural size.

The *lunare*, as stated above, is strongly convex from before backwards on its proximal aspect, and is closely applied to the scaphoid. Below it is strongly saddle-shaped, and articulates with the magnum, centrale and unciforme. It joins the cuneiforme by a moderately well-defined facet.

The *cuneiforme* is relatively large, and resembles the corresponding bone in the carpus of the bear. It presents a strong lateral process, which, when the bone is placed in its natural position on the unciforme, reaches over and almost touches the fifth metacarpal. The facet for articulation with the styloid process of the ulna is a wide, transversely extended groove, which is separated from the pisiforme facet by a high, transverse ridge. The distal surface has a cup-shaped facet where it articulates with the unciforme.

The *pisiforme* is robust and has a rather short, expanded tuber, which is very rugose for tendinous attachment. Otherwise this bone closely resembles that of the bear.

The *unciforme* differs from both that of the bears and felines in that it has considerably less vertical depth in proportion to its width. The cuneiforme facet is less vertical than in these forms, and the facet for the lunar is more on the summit of the bone. Distally there are two facets distinguishable, which serve as points of articulation for metacarp. IV and V.

The *magnum* is very much like that of the cat, and has practically the same relations to the surrounding bones. It is excluded from contact in front with the scaphoid by the intervention of the centrale. The broad shelf-like projection upon its radial side is occupied exclusively by the centrale, and the trapezoid does not overlap it, as is the case with the cats; in this respect it resembles the bears more than the cats. Distally it presents a single surface for articulation with metacarp. III.

The *centrale*, the smallest element of the carpus, is somewhat irregularly shaped, and articulates with the following bones: above, its principal contact is with the scaphoid, but it also touches the lunar; upon the ulnar side it articulates with the magnum, while below it is supported by the magnum and trapezoid. Upon the radial side it is more or less wedge-shaped, and lies between the scaphoid and trapezoid. In the coössified scapholunar of the cat and the bear, that prominent wedge of bone which extends down upon the radial side of the head of the magnum, and rests upon the ledge of this latter bone, undoubtedly represents the centrale.

The *trapezoid* is proportionately small, and does not lap over upon the magnum as it does in the cat. It is apparently not placed so high in the carpus as usual in the Carnivora, and therefore does not permit of the second metacarpal projecting above the level of the others, as so very frequently happens when the bones are closely articulated. It articulates above by two distinct facets with the centrale and scaphoid, and upon the ulnar side with the magnum; upon the radial side with the trapezoid, while below it supports the second metacarpal. It has essentially the same shape as in most of the fissiped Carnivora.

The *trapezium* is chiefly remarkable for its unusual size. It is almost equal to the unciforme and greatly exceeds the corresponding bone in the carpus of the modern Fissipedia. Above it has a large facet for articulation with the scaphoid, and a smaller one by which it articulates with the centrale. Upon the ulnar side there is a facet for articulation with the trapezoid and the inner side of metacarpal II, while distally there is a rather large flattened articular surface by which it supports the first metacarpal. It is of much interest to note that in its size and general form this bone of *Patriofelis* resembles the aquatic Carnivores much more than it does any of the Fissipedia. In the sea-lion the trapezium is larger than the unciforme; its transverse diameter is almost if not quite equal to its vertical diameter; there is a large facet for the scapho-lunar and the facet for articulation with the first metacarpal is not convex from side to side. In the Fissipedia, on the other hand, the vertical diameter is always the greatest, the facet for contact with the scapho-lunar is relatively small, and the facet for the first metacarpal is convex from side to side. Now in *Patriofelis* the greatest diameter of the trapezium is transverse, there is a large contact with the scaphoid, and the facet for the first metacarpal is like that of the sea-lion. The corresponding bone of *Oxyæna* resembles that of *Patriofelis* very closely.

Of the *metacarpals* the third and fourth are about equal in length and the longest, after which comes the second, fifth and first in the order mentioned. In the matter of size and robustness of the shaft, metacarpal I holds the first place, although there is some reason to believe that in the specimen here figured this bone is slightly pathological, which makes it appear larger than it would otherwise be if such were not the case. In the bone of the opposite side we have unfortunataly only the proximal end preserved, so that this point cannot be fully determined. At all events it can be stated that metacarpals I and V were well developed and relatively much larger and stronger than in the Fissipedia. One noticeable feature about the metacarpals is that the interlocking is but very slightly developed, and that the foot was broad and the toes well spread apart, which would lead to the conclusion that it was webbed. The distal ends of the metapodials all possess distinct keels, which are confined to the palmar half of the articular surfaces. The dorsal portion of these surfaces present that peculiarly distinctive hemispherical pattern so characteristic of the Fissipedia, and which appears to be altogether different in the seals. No especial mention need be made of the phalanges, further than to state that they are rather broad, depressed, and slightly curved, as in the Fissipedia.

The bony *claws* differ markedly from those of the Fissipedia, in that they are not laterally compressed and pointed, as is universally the case in this group, but follow the pattern of the Creodonta in having a deep cleft at their distal extremities. So far as is known, this character appears to be a very constant one in all the Creodonts, and is one of the features by which they can be easily recognized. The claws in *Patriofelis* are not so much depressed as they are in other Creodont genera, notably *Mesonyx*, and they are, moreover, considerably curved. There does not appear to be any trace of the bony hood or sheath enclosing the base which is developed to a greater or less extent in all the modern Fissipedia. There is another feature of the claws which is worthy of note, and that is the development of the subungual process. In the sea-lion this process is so large, especially in the fore limb, that it constitutes the greater part of the bone, and there is but the faintest trace of that part which bears the corneous sheath; yet a distinct depression upon the dorsal surface marks its position. The subungual process is not so large in the three middle digits of the hind foot, and the bony claws are well developed. In all the ungual phalanges there is a large, distinct foramen (the subungual foramen) which pierces the process transversely. This is more marked in the hind than the fore foot. In the Fissipedia, on the other hand, the subungual process is comparatively small, confined to the posterior part of the bone, and never overshadows the true bony claws, as it does in the seals. Traces of the subungual foramen exist, but they are minute and inconsiderable. In *Patriofelis* the subungual process is well developed, and extends forward, beyond the middle of the under surface of the claw, and the foramen is large and distinct, as it is in the sea-lion. In this respect the claws of *Patriofelis* are intermediate between those of the Fissipedia and the Pinnipedia.

Hind Limb.—The *pelvis* presents a number of marked anatomical characters which are apparently not found in any of the modern Carnivora at least. The ilium is well developed, and in proportion to the entire length of the pelvis exhibits about the same relative length as in the dog, cat and bear, and is therefore much greater than in the sea-lion. The chief peculiarity of the ilium of *Patriofelis* is its very unusual shape. It may be described as consisting of a strong trihedral bar of bone, the superior border of which is expanded into a broad lamina with a concave external surface. It therefore presents three distinct surfaces, of which one is directed internal, one upwards and outwards, and the other downwards and outwards. Of the two external surfaces the upper one, which served for the fleshy origin of the median gluteal muscle, is the larger and, as already stated, very concave. The inferior external surface is of less extent, and does not present any especial feature of interest further than to indicate a rather unusual size for the large gluteal muscle. The anterior end of the ilium is thickened and everted. A short distance in front of the acetabulum is seen a prominent roughened area for the tendinous origin of the *rectus femoris*. The acetabulum is rather shallow, and, as in the sea-lion, the roof of the cavity is not so thick and strong as it is in the fissiped Carnivores. It has a broad cotyloid notch, as in the dog.

The *ischium* is relatively broad and flat, with a prominent and somewhat elongated spine. There is little or no thickening of the bone at its posterior end to form the ischial tuberosities as in the Fissipedia, in this respect resembling the sea-lion. The obturator or thyroid foramen is large, slightly oval in form, and the two pubes are not united by bone at the pubic symphysis, which is long. The anterior edge of the symphysis lies considerably behind the acetabulum and not opposite its middle as in the Fissipedia. The ilio-pectineal eminence is prominent and intermediate in size between that of the dog and sea-lion.

The *femur* is large and powerful. It exceeds the tibia both in length and size. The globular head is set upon the shaft by a moderately short well-constricted neck, and exhibits a slight pit for the attachment of a *ligamentum teres*. The greater trochanter is strong and rises to a level with the head of the bone. It is roughened for muscular attachment, and has a deep digital fossa. The lesser trochanter is well developed, and is connected with the greater trochanter by a faint though well-curved intertrochanteric line. As in all the Creodonts, there is a small though distinct third trochanter. In its upper portion the shaft is flattened from before backwards, but in its lower part becomes more cylindrical, and at its distal extremity is especially thickened. The rotular groove is well developed but does not extend so high up on the shaft as in the terrestrial Carnivores. In the strictly cursorial forms, such for example as the Canidæ, the upper extremity of the rotular groove extends to a point in front of the shaft, much higher than do the condyles upon the opposite side of the bone. In the sea-lions and the seals in general the reverse of this is true. In *Patriofelis* they are about equal in this respect. The condyles are not flattened from before backwards as in the sea-lion, and there is a peculiar thickness of the bone where they join the shaft, very much as in *Hyænodon* and *Oxyæna*. Of the two condyles the inner one is slightly the longer, the disparity being about equal to that seen in the puma.

The *patella* does not present any characters of unusual importance. It may be said of it, however, that it is relatively large and rather closely resembles that of the fissiped Carnivores.

The *tibia* is shorter than the femur, and is in every way more slender and delicate. If the length of the femur be expressed by 10, that of the tibia would be 8 or thereabout. The head of the bone is relatively broad with a moderately well-developed spine. The cnemial process is not so prominent as it is in either the dog or the puma, but it is thicker and extends down the shaft for a greater distance. It is, however, much better developed than it is in the sea-lion, in which it may be said to be almost entirely absent. The distal end of the bone exhibits a strong internal malleolus, and an articular surface which shows but the faintest trace of that division into tongue and groove so highly characteristic of the higher Carnivora. The surface is directed strongly outwards.

The *fibula* is unusually stout, quite as much so as in the sea-lion, but there is no tendency to bony union with the tibia, as in the seals. The proximal end is considerably expanded and roughened for muscular attachment. The shaft is straight, nearly cylindrical and expanded into a distal extremity. When the tibia and fibula are articulated and the femur placed in position the fore and aft plane of the proximal extremity of the tibia is directed slightly inwards towards the body, while the same plane of the distal extremity is directed somewhat outwards. It results from this that the tibia has a decided twist, which causes a distinct outward rotation of the foot. In the sea-lion this torsion of the tibia is very prominent, which together with certain modifications of the tarsus does not permit the foot to be moved in a line with the long axis of the body, and gives to the animal that very peculiar and awkward gait upon the land. In the terrestrial Carnivora, on the other hand, there is no torsion of the tibia visible, and the foot moves freely in the direction of the long axis of the body. This matter will again be discussed when we come to speak of the probable habits of *Patriofelis*.

The *pes* presents a number of interesting characters. It is short and spreading in contradistinction to the narrow, elongated, compressed type of the more typical cursorial Carnivora. The *astragalus* is very primitive in that the trochlea is but faintly indicated, and the head is placed upon the body in a very oblique position. If the fibular facet be taken to indicate a fore and aft direction, then the head projects inwards at an angle of 45° or thereabout. It is nearly as great as it is in the sea-lion, and very much greater than in any of the terrestrial Carnivora. The neck is notably short and stout, and its constriction much less pronounced than is usually the case. The tibia and fibular facets form nearly a right angle at their point of junction, whereas in the sea-lion it is an obtuse angle, and in the Fissipedia it is an acute angle. The trochlea or tibial facet is rather short from before backwards, slightly prolonged upon the neck, as in the seals and *Hoplophoneus*, and with a rather prominent antero-external angle, but not so great as in the sea-lion. There is a large and distinct astragalar foramen which is placed at the posterior termination and a little to the outer side of the trochlea. This foramen, as is well known, is highly characteristic of the primitive forms of many orders of mammals, and it is of especial interest to note that the seals are among the very few living forms in which it has been retained. It is also present, though small, in the Miocene genus *Hoplophoneus*. The calcaneal facet is rather flat from before backwards, as in the sea-lion and *Hoplophoneus*, and does not have the deep saddle shape as in the Fissipedia. It is separated from the sustentacular facet by a moderately deep, wide groove. The sustentacular facet has its usual position but displays some characters peculiarly its own. It is continuous with the navicular facet by a narrow band around upon the inner side of the head, whereas in all the other forms in which these two facets are united it is always upon the outer or fibular side of the head. The facet for the navicular is oval and flattened from above downwards. While it articulates with the cuboid as well as the navicular, this articular surface is not divided.

Fig. 5. *Patriofelis ferox*. Right pes, ¼ natural size.

The *calcaneum* has a short, stout tuber, somewhat laterally compressed beneath the astragalar facet, but produced into a thick more or less rounded tuberosity at its posterior extremity. The tuber is relatively much shorter than in any of the terrestrial Carnivores and approaches that of the sea-lion. The characteristic shortness of the heel in the seals is not due so much to the absolute brevity of the bony process as it is to the unusual backward prolongation of the astragalar facet, and there is in consequence a high degree of mobility of this latter bone upon the calcaneum. The astragalar facet is rather flat, and is not so steeply arched as in the dog, cat, or bear. It displays a more gentle curve, and spreads back further upon the tuber, as in *Hoplophoneus* and the sea-lion. The sustentacular facet is small, circular, and does not become continuous with the cuboidal facet, as is the case in the sea-lion. The facet for the cuboid is oval, cup-shaped, and the antero-external angle is produced in such a manner as to give it a marked obliquity in conformity with the peculiar shape of this latter bone. There is a broad, thick, ledge-like process upon the outside and near the distal end, which has generally been accepted as a mark of a plantigrade gait. In the human foot this process serves for the attachment of the annular ligament, and is deeply grooved for the passage of the long and short peroneal tendons. It is of much greater size in the calcaneum of *Patriofelis* than in that of the bear. It is also large in the sea-lion.

The *cuboid* is a highly characteristic bone in the tarsus of *Patriofelis*. Proximally it has two facets separated by a distinct antero-posterior ridge, one of which is for the astragalus and the other for the calcaneum. If the bone be held in a vertical position, the facet for the calcaneum is wholly upon the outer side, and forms the external boundary of the bone, but as the cuboid is not placed vertically in the tarsus the facet is directed upwards and outwards when the bone is in its natural position. This great obliquity of the calcaneal facet is very unusual, and is not found in any of the living forms except the seals and the South American musteline genus *Galictis*. In neither of them, however, is it so highly developed as in *Patriofelis*. Distally there is a large concave facet which supports the fourth and fifth digits. Internally it articulates by a single facet with the astragalus and ectocuneiforme. The *navicular* presents the usual form found in the Carnivora, and does not call for especial mention. The *cuneiforme* bones, moreover, display the usual pattern of the Fissipedia, the internal one not being especially enlarged, as in the seals.

The *metapodials* are five in number, and like those of the fore foot, show comparatively little interlocking. They are shorter proportionately than in the dog or cat, but are equally, if not more, robust. They are about equal to those of the black bear in length, but are stouter in every way. The fourth is the longest and strongest of the series, after which comes the third, second, fifth and first, in the order named. They all possess distinct keels and globular-shaped heads upon their distal extremities. The *phalanges* resemble those of the fore foot in their form and general proportions, with the exception of their slightly greater length. The bony claws are all fissured at their extremities, and the subungual processes and foramina are well developed.

There yet remain to be mentioned in connection with the limbs two bones which, although they were not found in position, give every evidence of being a *radial sesamoid* and a *tibiale* (?). The radial sesamoid is relatively large, and is located at the inner extremity of the scaphoid, where it is found in the dog and bear. It appears to be altogether absent in the sea-lion. It is compressed from before backwards, and is slightly hollowed out at its distal end. The *tibiale* (?) has a similar shape to that of the radial sesamoid, but is not so large and not so much flattened. It articulates by a very distinct facet with the ento-cuneiforme, very much as in the dog, and not apparently with the ento-cuneiforme and navicular, as it does in the sea-lion, in which it is unusually large.

II.—Comparison with Other Creodonts.

A.—Comparison with Oxyæna.

In the foregoing description very little mention has been made of the nearly-related genus *Oxyæna*. The species of this genus, as is well known, have been found so far only in the older Wahsatch deposits. With the aid of the materials now in the Museum Collections I am able to give a comparative statement of the more important characters in the skeletal structure of these two genera. The species upon which this comparison is primarily based is *Oxyæna lupina* Cope, of which a somewhat fragmentary skeleton was collected by the Museum Expedition into the Big Horn Basin in 1891.

In the skull of *Oxyæna* we note the same peculiarity as regards the great disparity in size between it and the rest of the skeleton seen in *Patriofelis*. The face is short, the muzzle broad and truncated, the skull much constricted behind the postorbitals, and there is a long interval between the postorbitals and the anterior termination of the brain cavity. The sagittal crest is, moreover, high and prominent and extended well forward in advance of the brain-case. There are two large postparietal foramina as in *Patriofelis*, and the glenoid cavities have anterior and posterior glenoid processes. The mastoid and paroccipital processes are prominent, and there is evidence of the existence of the same peculiar foramen piercing their posterior wall as seen in *Patriofelis*. In the lower jaw the rami are relatively deep, with a straight inferior border; the chin is abruptly rounded, the symphysis is short, the condyles well extended transversely and scroll-like in pattern; the angle is rounded and not produced into a hook, and the coronoids are broad and high.

In the teeth some important differences are to be observed, which separate the two genera very sharply. In our paper[1] we made the statement that our specimens demonstrate the existence of three incisors in the lower jaw. This, I think, is an error, for I cannot discover any evidence in support of this proposition. Cope expressed the opinion that there were only two incisors in the lower jaw, and I see no evidence for a contrary view. The dental formula, I. $\frac{2}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{4}$, M. $\frac{2}{2}$, shows some important modifications as to the number of teeth in the molar and premolar series. In this, *Oxyæna* is the more primitive, as we would be led to infer by reason of its being the older genus of the two. *Patriofelis* has discarded one molar from the upper series, and a premolar from both the upper and lower series, if my conclusions are correct in regard to the dentition. The last lower molar has, moreover, been modified into a true sectorial tooth, consisting of only the two blades, whereas in *Oxyæna* this tooth possesses the internal cusp and the talon as well.

In the vertebral column the atlas of *Oxyæna* resembles that of *Patriofelis* very closely. The other cervicals, so far as they are known, have the same general characters as those of *Patriofelis*. The lumbars do not apparently have as highly complex zygapophyses as those of the Bridger genus, but the approach in this

[1] Fossil Mammals of the Wahsatch and Wind River Beds, Bull. Amer. Mus., Vol. IV, 1892, p. 108.

direction is very marked. *Oxyæna*, like *Patriofelis*, had a long and powerful tail, the sacrum being unknown.

Of the fore limb the scapula is somewhat fragmentary, but the greater part of both heads is preserved. The glenoid cavity has the same general form as in *Patriofelis*; as in this genus, moreover, the neck is very short, the spine rising almost immediately behind the border of the cavity. The spine itself is considerably damaged, so that the question of the acromion and the metacromion cannot be determined, but if we are to judge by the great similarity between the heads of the two bones, it is highly probable that a metacromion was present. In the humerus we note a most striking similarity. The deltoid crest is prominent and extends almost the entire length of the shaft; there is an entepicondylar foramen, but no intercondylar foramen. The humeral trochlea is very similar in the two genera, and the internal condyle is extended downwards into a broad flange-like process. The ulna has the same powerful olecranon process, and is deeply grooved, as in *Patriofelis*. Of the radius very little is known. The manus is strikingly like that of *Patriofelis*, with the exception that it is more slender and weaker in every way. In the carpus there is a free scaphoid and lunar, a centrale is present, and the trapezium is singularly enlarged, as it is in *Patriofelis*. The metacarpals have about the same relationship to each other as in the Bridger genus, and the interlocking is comparatively slight. The phalanges appear to be somewhat longer, and the claws not so deeply cleft as in *Patriofelis*. The subungual processes are well developed, and the foramen is present and large.

In our *Oxyæna* material the pelvis is not well represented, but Scott says of it:[1] "The pelvis differs from that of the typical Creodonts in having an expanded ilium, and wide, flattened ischium," a character which agrees well with *Patriofelis*. The femur appears to be a trifle shorter in proportion to its size, the distal end is more flattened from before backwards, and the rotular groove is not so well marked. There is a small, though distinct, third trochanter, and the head of the bone has a pit for the *ligamentum teres*. Of the tibia we note the same general

[1] A Revision of the North American Creodonta. Proceed. Philad. Acad., 1892, p. 315.

form in the proximal extremity, with the exception of the unusually weak development of the cnemial crest, which is quite as flat as it is in the seals. In its distal extremity the astragalar facet is relatively small, but very little grooved, and not so oblique as in *Patriofelis*. The fibula is large and has the same character as in the Bridger species. The pes is remarkably similar in the details of its construction to that of *Patriofelis*. The astragalus has the same flat tibial facet; there is a large astragalar foramen, and the head is set upon the body of the bone so as to be very oblique. In the calcaneum the tuber is short, the astragalar facet is long and little arched, and the cuboidal facet is very oblique. The cuboid, moreover, shows the same remarkable oblique facet for the articulation with the calcaneum, and it also has a large facet where it joins the astragalus. The metapodials are not completely known, but what knowledge we do have of them, renders it all but certain that there are no important differences between the Wahsatch and Bridger genera. Indeed, the similarity between the limb structure of the two forms is so great that did we not know that there are considerable differences in the teeth we would not hesitate to refer them to one and the same genus.

B.—Comparison with Hyænodon.

This genus, as is well known, comes from the Lower Miocene or White River deposits. Although much of the skeleton has been described, very little apparently is known of the hind limb. A comparison of the skull of *Patriofelis* with that of *Hyænodon* shows some important differences, which to my mind render it extremely doubtful whether they should be placed in the same family. The general form of the skull is strikingly like that of the dog, the muzzle is long, narrow and pointed, in marked contrast with that of *Patriofelis*, which is short, broad and truncated. The skull is moderately constricted behind the orbits it is true, but the long interval between the postorbitals and the anterior termination of the cranial cavity is not found; it is about equal in this respect to the dog and the cat. The sagittal crest is not extended in advance of the brain cavity as it is in *Patriofelis*. The lachrymal is extended out upon the face, as was noted by

Scott,[1] a character which is not found in *Oxyæna* at least. The anterior glenoid process is wanting, the mastoid is much reduced, and there is a post glenoid foramen present. The mandibular condyles have comparatively little lateral extension, and the angle of the jaw is produced into a blunt hook-like process, which has a strong inclination inwards. The rami are long, shallow and much curved upon the inferior border; the chin is long and pointed, and the symphysis singularly elongated. These characters stand out in bold relief from those already noted in *Oxyæna* and *Patriofelis*.

In the dentition again there are three incisors in the lower jaw as well as three true molars, whereas both *Patriofelis* and *Oxyæna* have only two. In the fore limb the scapula is unknown, the humerus has the usual Creodont characters, which may also be said to be true of the ulna and radius. The carpus differs from that of *Patriofelis* and *Oxyæna* in the proportions of some of the bones, but in the enlargement of the trapezium it resembles them. In the hind limb the ilium is said by Scott (l. c.) to be feline in appearance and to have the gluteal surface little expanded. He also describes a large contact between fibula and calcaneum. The transverse processes of the atlas are also stated by this author to be imperforate.

These characters, it seems to me, weigh strongly against the conclusion that there is any near relationship between *Hyænodon* and either *Patriofelis* or *Oxyæna*, as is believed by Scott. *Hyænodon*, moreover, is the most modern of all the Creodonts, and if it has been derived from *Oxyæna* it must have been from a species much more primitive than any yet known belonging to that genus. I think it much more probable that *Stypolophus* was the ancestor of *Hyænodon*, since in this form we have all the conditions satisfied, so far at least as we know its osteology. This cannot be satisfactorily determined, however, until we know the Uinta representative of the White River Creodont.

C.—Comparison with Palæonictis.

There is but one other family with which it is necessary to compare *Patriofelis*, and that is the Palæonictidæ. Unfortunately

[1] Some Little-known Creodonta, Journal Philad. Academy, Vol. I, 1886, p. 177.

we know very little of the osteology of either of the two genera composing this family. They are both short muzzled types, and in one at least (*Palæonictis*) there was a full complement of incisors in the lower jaw. The upper molars do not exhibit the sectorial pattern of either *Oxyæna* or *Patriofelis*, and it is highly probable that they form a distinct family. I have elsewhere[1] called attention to their relationship with the Felidæ.

III.—Comparison with the Seals.

It yet remains to compare the skeleton of *Patriofelis* with that of the modern Pinnipedia. This group, as is well known, is the most distinct and aberrant of all the Carnivora. The large number of trenchant anatomical characters by which they are distinguished from their nearest allies is strong presumptive evidence of the fact that their ancestry is to be traced far back into Tertiary times. It is moreover highly probable that much of the extreme modification by which they are now characterized will not be found to pertain to their ancestors, inasmuch as no Creodont or primitive Carnivore is known whose limb structure would lead one to suppose that it was exclusively aquatic, as the seals now are.

There is, however, much evidence to convince us, as I will presently attempt to show, that this group at least of Oxyænidæ included animals accustomed to seek their food in the water, and were partially adapted to an aquatic life.

The *principal osteological characters* of the Pinnipedia may be briefly summarized as follows:[2] In the *skull* the face is remarkably short, the interorbital constriction pronounced, and there is a long interval between the anterior termination of the brain and the postorbital processes when they exist. There is no lachrymal bone or canal, and there is a large vacuity in the inner wall of the orbit. The brain-case is broad, and in the least specialized forms is surmounted by a high and prominent sagittal crest, which

[1] Fossil Mammals of the Wahsatch, Bull. Amer. Mus., Vol. IV, 1892, p. 96.

[2] See Prof. J. A. Allen's 'Monograph of the North American Pinnipeds,' U. S. Geol. Survey, F. V. Hayden, 1880, a most important work; also 'The West Indian Seal,' *Monachus tropicalis*, by the same author. Bull. Amer. Mus., Vol. II, 1887, pp. 1–34.

extends forwards to the postorbitals. There may or may not be an alisphenoid canal or an anterior glenoid process present. The mastoids are conspicuous, and the tympanic bullæ are either conspicuous and inflated or small and rugged. There is no postglenoid foramen. The teeth have an unusually simple pattern. The true molars are never more than two, and the entire molar and premolar series never consist of more than six teeth. The incisors in the lower jaw of both the temporary and milk series never exceed two pairs. The *vertebræ*, in some of them at least, show marked traces of the complex articulations of the pre- and postzygapophyses of the lumbar region, so common in the Creodonts. The *feet* are pinniform, with the digits of the manus decreasing in length and size from the first to the fifth ; the true ungual processes of the ungual phalanges are either distinct and terminal or altogether abortive, in which case, they are replaced by subungual processes, which are always large, the first three being pierced by a foramen. The trapezium is as large or larger than the unciforme ; the ulna has a powerful and elongated olecranon process ; the humerus is shorter than the scapula, and has an enormous deltoid crest which extends nearly the whole length of the shaft ; the entepicondylar foramen is either present or absent. The scapula is broad with a well-developed supraspinous fossa, and a short neck and rudimental metacromion process.

In the *pelvis* the ilia are short with the anterior border much everted ; the pubes barely meet in a short symphysis which lies behind the acetabulum and is never anchylosed. The cotyloid notch is much reduced or altogether absent, and there is no pit for the *ligamentum teres*.

The *femur* is remarkably short, much compressed from before backwards, the digital fossa is small or absent, and there is no third trochanter. The fibula, which is large, is coössified with the tibia ; the cnemial crest is weak or absent, and the tibia has a very decided twist. The tibia-astragalar facet is plane, without the tongue and groove of the Fissipedia ; in some of them at least (*Zalophus*) there is a vestigial astragalar foramen present. The tuber of the calcaneum is short; there is large contact between the astragalus and cuboid, and the calcaneo-cuboidal facet is very oblique, as in *Patriofelis* and *Oxyæna.* To this should be added the large size of the external calcaneal tubercle. In the pes the first and fifth digits are the largest, with the three middle ones shorter and subequal. Of the ungual phalanges the subungual processes are well developed and perforated by the subungual foramen.

The Pinnipedia are divided into three families, of which the Otariidæ are in many respects the most primitive. This is seen more especially in the characters of the hind limbs, which can support the body in the ordinary way, and can be used to a considerable extent for progression upon the land, whereas in the more typical seals (Phocidæ) this is not the case. Other characters which cause them to be regarded as the most primitive members of the group are seen in the presence of postorbital processes, the high sagittal crest, an alisphenoid canal, an anterior glenoid process, small and rugged tympanic bullæ, a prominent mastoid process, a rudimental cotyloid notch of the acetabulum, presence of trochanter minor of the femur, and a more normal astragalus, which frequently shows distinct traces of the astragalar foramen. They are more specialized than the Phocidæ in the following characters: absence of entepicondylar foramen of humerus, rudimental condition of the true ungual processes in all the digits of the manus, absence of digital fossa of femur, which however is not found in all the Phocidæ, and lack of complication of the lumbar zygapophyses.

From a careful survey of the foregoing osteological characters of the Pinnipedia, in connection with what we already know of the development of the Carnivora from the Creodonta, I think that the following propositions may be fairly deduced: (1) *They are descended from ancestors in which the tibia-astragalar facet was not grooved,* for the reason that there is no Carnivore known in which the groove has ever been obliterated when once formed.[1] The ungrooved astragalus is characteristic of all the Creodonta, with the exception of one family, Mesonychidæ. (2) *They are descended from a short muzzled type in which there was great reduction of the true molars, and comparatively little reduction of the*

[1] Even in such an exclusively aquatic form as the sea otter the astragalar groove is very distinct, notwithstanding the fact that the digits of the pes are highly modified.

premolars, for the reason that there are never more than two true molars and very frequently one.[1] (3) *They are descended from a type in which the incisors of the lower jaw were reduced to two pairs.* This proposition I regard as established from the fact that none of them possess more than the two pairs in the lower jaw in the adult dentition, and according to Allen,[2] there are only two pairs of incisors in the lower jaw in the milk dentition of the Otariidæ, which seems to point to the fact that they were lost at an extremely early period. (4) Their ancestors possessed in addition the following important characters: Skull with interorbital region constricted and long between postorbitals and the anterior termination of the brain-case; an alisphenoid canal; an anterior or preglenoid process; a prominent mastoid; a metacromion process of the scapula; an entepicondylar foramen of the humerus and a prominent deltoid crest; a long and powerful olecranon; an enlarged trapezium; a free scaphoid, lunar and centrale; a short unanchylosed pubic symphysis; a femur with a digital fossa; an unreduced fibula; an astragalar foramen; a cuboid with a very oblique facet for the calcaneum and a large contact with the astragalus; a calcaneum with a relatively short tuber and ungual phalanges, with well-developed and large, perforated subungual processes. (5) Their ancestors were, judging from these characters, not exclusively, but semi-aquatic in habits, with limbs fitted for progression upon the land.

If now we examine the skeleton of *Patriofelis* in connection with these probable ancestral characters of the seals, we find that there are some striking features of likeness between the two groups. These characters, moreover, are found in such widely different parts of the skeleton, that I think they can hardly be due to convergence or parallelism.

Features common to Patriofelis and the Seals.—In the *skull* we note the *short muzzle* and long much-constricted region between the postorbitals and the anterior termination of the brain-case; there is an alisphenoid canal present, as well as a well-developed preglenoid process; the mastoids are prominent in both, and there is no postglenoid foramen. There are but two pairs of

[1] See Huxley's 'Anatomy of Vertebrate Animals,' p. 363.
[2] Loc. cit., p. 3.

incisors in the lower jaw, and the molar dentition is much reduced. In the fore limb the humerus is shorter than the scapula, and provided with a great deltoid crest and an entepicondylar foramen. The scapula is large, with short neck and metacromion process. The ulna has the same powerful olecranon, which, together with the prominent deltoid crest, however, appears to be very common among the Creodonts. The trapezium is enlarged ; the feet are broad and spreading, and in the ungual phalanges, the subungual processes are largely developed.

In the vertebral column, as already noted, some of the seals (notably *Phoca vitulina*) show marked traces of the complex articulation of the lumbar zygapophyses. The pubic symphysis of *Patriofelis* is short, lies behind the acetabulum, and is not anchylosed. The fibula is large and unreduced in both groups ; the trochlea of the astragalus is not grooved ; the tuber of the calcaneum is short, and the cuboid has a very oblique calcaneal facet and a large contact with the astragalus. The foot is broad and spreading, and the ungual phalanges have perforated subungual processes.

Probable Habits of Patriofelis.

From the structure of the limbs more than any other feature in the osteology of *Patriofelis*, I am led to conclude that it was aquatic or semi-aquatic in habits. The broad, flat, plantigrade feet, with their spreading toes, suggest at the first glance their use for swimming. The eversion of the feet, together with the general clumsiness of the limbs, point, moreover, to the fact that the animal was not an active runner. Now, if the animal was aquatic, what was the nature of its food ? It certainly could not have been fish, for the reason that the remains of fishes are very scarce in the Bridger sediments. If, however, we can form any judgment from their remains, I think that it can be safely stated that the Bridger Lake *literally swarmed with turtles*, and if *Patriofelis* frequented the water, it is highly probable that they formed a staple article of its diet. This supposition accords well with the great strength and power of the jaws, together with the robust and much-worn condition of the teeth. There is another fact which may be mentioned in this connection, which has a direct bearing upon this conclusion, and that is the existence of coprolites in the Bridger sediments containing fragments of turtle shells. This, while it is not at all conclusive, yet demonstrates that there was an animal living on the borders of the ancient lake, that was accustomed to capture turtles for food, and from what has already been stated, I think that animal was *Patriofelis*. He was, perhaps, not as expert a swimmer as the seals now are, but was sufficiently active in the water to capture turtles. When the lake disappeared, it can be conjectured that *Patriofelis* took to the open sea, and finally came to feed upon fish exclusively. It is further conceivable that in their new habitat their swimming power was gradually increased, and, owing to the soft nature of their food, the great strength and power of the jaws were gradually lost, and the teeth became gradually modified into the simple degenerate organs which constitute the dental equipment of the modern Pinnipedia.

IV.—Classification and Species of Patriofelis.

It will be seen from what has already been stated that *Patriofelis* is a member of the Creodonta. Various efforts have been made from time to time to give an exact definition of this group, but these definitions have as yet proven very unsatisfactory. That the Creodonta stand in general antecedent relationship to the Carnivora is now abundantly demonstrated, but whether the Carnivora arose from one or several stems of the Creodonta, is still an open question. It is held by Cope and Scott that all the Fissipedia are descended from the Miacidæ of the Credonta. I have expressed a contrary opinion, with Schlosser, in regard to the cats.

One of the chief osteological distinctions between the Creodonta and the Carnivora consists in the union of the scaphoid, lunar and centrale in the carpus of the Carnivora, whereas they are free in the Creodonta. There are, moreover, such characters as the fissured ungual phalanges, the complex articulations of the lumbar vertebræ, the relative size and degree of convolution of the cerebral hemispheres, and a number of other characters of less importance which serve to distinguish these groups from each other. It must be borne in mind, however, in considering these differences, that if the Carnivora have been derived from the Creodonta, the distinctions between them must have been exceedingly slight at the point where they actually meet, and that any definition which can be given will, according to the very nature of the case, fail. There is considerable evidence to show that wherever the Creodonta continued beyond the Lower Miocene they took on certain characters which now so sharply distinguish the Carnivora. In the Miocene genus *Hyænodon*, the cerebral hemispheres were almost, if not quite, as well convoluted as their carnivorous cotemporaries, and in the European species of the same genus, according to Scott, the scaphoid, lunar and centrale were united as well. In a like manner many of the Miocene Carnivora show marked traces of their Creodont ancestry. This is especially seen in the flat astragalus and the remains of the suture uniting the scaphoid and the lunar, as well as the simpler type and less convoluted cerebral hemispheres. It would appear, therefore, that these groups, being incapable of exact definition, have lost much of their original significance, and are now to be regarded as mere matters of convenience in classification. The same may be said of the Insectivora with relation to the Creodonta.

The systematic position of *Patriofelis* within the Creodonta is not difficult to discover. Its general skeletal structure is so much like that of *Oxyæna* that, notwithstanding the differences in the teeth, they must be placed in the same family. *Oxyæna* is the older form, and has the more primitive dentition, but the differences are not greater than we would be led to anticipate in the ancestral genus. I think that it can be accepted as demonstrated that *Patriofelis* is the direct descendant of *Oxyæna*, which may have likewise given off a branch which terminated in the modern seals. It is somewhat doubtful whether this branch leads through *Patriofelis*.

Regarding the relationship of *Patriofelis* to *Hyænodon* I have spoken on a former page. I do not think that they can be consistently associated in the same family.

The family definition may now be stated as follows:

Oxyænidæ.—Muzzle short and truncate; interorbital region constricted and elongated; sagittal crest extended well in advance of the brain-case. A preglenoid process and no postglenoid foramen; an alisphenoid canal and prominent mastoid. Lachrymal bone not extended out upon the face. Two pairs of lower incisors. Trapezium enlarged; pubic symphysis not anchylosed; fibula unreduced; calcaneo-cuboidal facet very oblique; cuboid having large contact with astragalus. Fibula not articulating with calcaneum.

Oxyæna Cope.—Premolars in the lower jaw 4, molars 2. Last superior molar transverse.

Patriofelis Leidy.—Premolars in lower jaw 3; molars 2, Last superior molar longitudinal.

The species are not numerous, and it is indeed questionable whether more than three should be referred to *Patriofelis.* Leidy's type species *P. ulta* is easily distinguished by its small size; it is scarcely more than half as large as *P. ferox.* I have chosen to regard Cope's species *P. tigrinus* as distinct chiefly on account of its having come from an older formation, although there is no character observable in the fragmentary specimen of *P. tigrinus* to warrant such a belief. When we have better specimens of it, however, it will doubtless show a nearer relationship to *Oxyæna* than to the Bridger species. There is yet another species which was described by the writer[1] under the name of *Patriofelis leidyanus.*[2] It was stated at the time that its reference to the genus *Patriofelis* is doubtful. I am now convinced that it does not belong here, but is probably a forerunner of the Miocene Nimravidæ. Until more of it is known it is impossible to give to it a generic definition, and I therefore refrain from proposing a new name.

[1] Fossil Mammals of the Wahsatch, Bull. Amer. Mus., Vol. IV, 1891, p. 98.

[2] This species, together with the figure of it, is erroneously attributed by Zittell, in his 'Handbook of Palæontology,' to Osborn.

Article VI. — ON THE MAMMALS OF ARANSAS COUNTY, TEXAS, WITH DESCRIPTIONS OF NEW FORMS OF LEPUS AND ORYZOMYS.

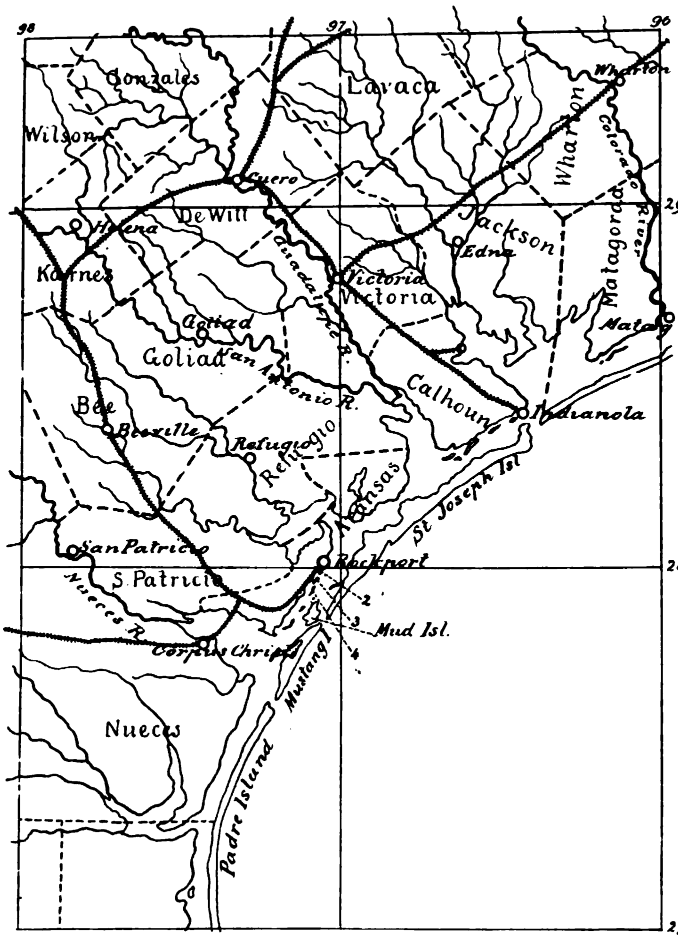
By J. A. Allen.

The following paper on the mammals of Aransas County, Texas, is based on a collection made by Mr. H. P. Attwater during the years 1892 and 1893. The collection numbers about 300 specimens, representing 24 species, in most instances by good series of both young and old. About three-fourths of the specimens have been purchased by the Museum, the rest being reserved by Mr. Attwater for his private collection. They have all been kindly forwarded to the Museum for study, and I am further indebted to Mr. Attwater for the valuable field notes presented in the following pages.

The present collection is especially interesting from having been gathered from a very limited area, for the most part within a radius of ten miles of the town of Rockport. As shown on the accompanying map, Aransas County consists of a number of small islands and of several irregularly shaped peninsulas formed by the extension inland of various bays. The specimens were collected partly on the mainland, on marshy ground in the immediate vicinity of Rockport, and partly on the adjoining small islands numbered 2, 3 and 4 on the accompanying map. They doubtless fairly represent the mammalian fauna of this very limited area, but probably a number of additional species occur in other parts of the county. These would probably include a number of additional species of Bats, perhaps one or two Shrews, and a Harvest Mouse (*Reithrodontomys*). No species of Kangaroo Rat was met with, and Mr. Attwater is very confident that none occurs within the area covered by his explorations.

As marked changes have already occurred in the mammalian fauna of Aransas County since its settlement, it has seemed desirable to include in the list a few species that have already become nearly or quite extirpated. The total number of species is thus increased to 36, about ten being given solely on the basis of Mr. Attwater's notes.

The notes kindly furnished by Mr. Attwater are here given in substance, and generally in his own words. Although sometimes condensed and somewhat changed in form, it has been thought best to present them as though they were direct quotations from



Map of Aransas and Adjoining Counties.—The collection was made chiefly on the small islands numbered 2, 3 and 4, and on a low, marshy point close to the island marked 1, sometimes referred to in Mr. Attwater's notes as the 'Point' or 'Pocket.'

his notes and letters, and to further distinguish them by his initials. They include also the following paragraphs respecting the general character of the area in question.

"Aransas County, with Rockport as the county seat, lies on the Gulf coast of Texas, between the Guadaloupe and Nueces Rivers, and about half way between Galveston and the mouth of the Rio Grande. It comprises an area of 437 square miles, and includes Live Oak, St. Charles and Lamar Peninsulas, and St. Joseph Island, which latter extends along the Gulf for 28 miles; the remainder of the county is made up of Aransas, Copano, Puerto, and St. Charles Bays, in which are situated a number of shell reefs and small islands.

"The prevailing tree growth on the peninsulas consists of dwarfed live oaks, 'sweet bay' (*Persea carolinensis*), and 'huckleberry' (*Vaccinium arboreum*), with scattered groups of anaqua (*Eluetia elliptica*), hackberry, mezquit, and prickly ash. The shell ridges along the shores and on St. Joseph and the smaller islands are covered with a tangled growth of 'chaparral,' consisting chiefly of dwarfed persimmons, huisache and 'cat-claw,' with patches of dewberry vines and occasional bunches of prickly pear (*Opuntia*). On St. Charles Peninsula is a considerable area of black-jack oaks.

"Along the shores is a belt of comparatively open country, of an average breadth of half a mile, covered with a dense growth of weedy plants, the most common being 'wild sage' (*Croton texensis*), *Eupatorium*, *Cassia*, *Baptisia*, *Helenium*, and *Amphiachyris*. On the salt flats *Statice* and *Lycium* grow in abundance. The most common grasses on the uplands are Bermuda and burgrass (*Cenchrus tribuloides*).

"Back in the interior the vast mezquit lands of the West meet the black 'hog wallow' prairies, which extend along through the coast counties from Louisiana into southeastern Texas.

"'The narrow belt of the Tropical Realm, which extends northward along the Texas coast from the Lower Rio Grande,' begins to disappear in Aransas County, and probably dies out in Calhoun County, adjoining Aransas on the east, the northern limit being near the mouth of the Guadaloupe River. About here

I think will be found the extreme limit in southern Texas of the range of such southern birds as the Vermillion Flycatcher, Chaparral Cock, Cactus Wren, Paraque, White-tailed Hawk, and some others."

1. **Didelphis marsupialis californica** (*Bennett*). TEXAS OPOSSUM.—Represented by three adult specimens, taken Jan. 10, Feb. 5 and Feb. 10. Two of these agree with three others from Corpus Christi and another from Brownsville in the surface of the pelage being black; the other specimen differs in having a very full covering of long pure white bristly hairs, which largely conceal the blackness of the finer pelage below.

In the absence of specimens from the supposed type locality of Bennett's *Didelphis californica* (P. Z. S., 1833, p. 40), said to be "from that part of California which adjoins Mexico," I follow Professor Baird in referring to this form the Texas series of Opossums. The Texan animal, as represented in the coast region of Texas, differs from the northern *D. m. virginiana* not only in the generally much darker color, but in the presence of a well-defined blackish eye-stripe and wholly black feet. In a series of 24 specimens from the vicinity of New York City the whole head is much lighter (nearly white), the eye being merely surrounded with a dusky border, most developed in front of the eye; there is also no eye-stripe nor median frontal stripe as in the Texas specimens. The apical portion of the toes of both fore and hind feet is white, as a rule, the white, however, varying in extent, being sometimes limited to the terminal phalanx, and sometimes involving the greater part of the foot. In Texan specimens the black also extends much further on the tail, involving the basal third or half, or even more, instead of being confined to the extreme base, as in northern examples; and the tail is also very much longer.

"Opossums are very common all over the peninsulas of Aransas County, and I think also on St. Joseph Island. They frequently come into town at night after chickens, and during summer, when the doors and windows are open, enter houses and explore the premises. One was caught lapping milk that had been left on a table in a kitchen. Several were sent to me that had been killed in and near a house on the outskirts of town. They vary considerably in color, but none are very light."—H. P. A.

2. **Tatusia novemcinctus** (*Linn.*). NINE-BANDED ARMADILLO.—One specimen, St. Charles Peninsula, 20 miles northeast of Rockport, Oct. 1, 1893.

"Armadillos are found in several parts of Aransas County. The one sent is from St. Charles Peninsula, where I have heard of a number being seen. This is probably about the limit of their range to the eastward along the Texas coast."—H. P. A.

3. **Lepus callotis** *Wagler.* JACKASS HARE.—Represented by six specimens, including adults in both summer and winter pelage, and also young of various ages, from one apparently only a few days old (collected Oct. 11, 1893) to others half to two-thirds grown.

There appears to be no appreciable difference in coloration with age. There is, however, a marked seasonal variation. Summer specimens have the pelage much shorter, thinner, and somewhat lighter in color (less fulvous and grayer) than winter specimens, with a broad, long (about 75 by 35 mm.) jet black nape patch of fine, short fur, usually divided posteriorly by a narrow stripe of gray, formed by a slight tipping of gray to the black hairs. This stripe varies in extent and distinctness in different specimens. In full winter pelage the black nape patch is wholly wanting, and the general pelage is much fuller, longer, and more strongly fulvous.

Mr. Attwater gives the weight of two adult specimens as follows: ♀, Nov. 8, 6 lbs. 6 oz.; ♂, Sept. 18, 6 lbs. The length of the hind foot in each of these specimens is given on the label as 5.25 in. (= 133 mm.).

Two other specimens collected by Mr. Frank M. Chapman[1] at Corpus Christi, April 16 and 25, and hence in short summer pelage, are evidently referable to the same form.

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[1] Mr. Chapman collected at Corpus Christi from March 18 to April 25, 1891. His report on the birds he collected has already been published (this Bulletin, Vol. III. pp. 315–328), as have his notes on two of the mammals (l. c., pp. 284, 285, and 288, 289). Further frequent references will be made to the mammals in the present paper.

These specimens are all provisionally referred to *Lepus callotis*, originally described from some part of Mexico, of which Dr. Mearns's *Lepus melanotis*,[1] from Kansas and Oklahoma Territory, seems to be merely a larger, rather more fulvous northern subspecies.

"Jack Rabbits are common all over the country, and do considerable damage to gardens. Many of the smaller truck farms are surrounded by rabbit-proof fences for protection from their depredations. The State passed an act two years ago (1892) placing a bounty on them, and they have now become much scarcer. They are also sold in the poultry and game shops, being brought to town from a distance by Mexicans and others. I understand that the bounty was removed at the last session of the legislature, some of the southwestern counties of the State not having money enough to pay the bounties on these and other animals included in the act.

"Jack Rabbits are now very common on St. Joseph Island, where I am told they were introduced during the late war.

"These animals are sometimes taken young and kept alive; but they are always wild and very pugnacious. The species appears to breed at any time, its food being easily obtainable at all seasons. I think they have only one young at a time."—H. P. A.

4. **Lepus sylvaticus bachmani** (*Waterh.*). Texan Wood Hare.—Eleven specimens of this form of the Wood Hare are contained in Mr. Attwater's collection, and eleven in Mr. Chapman's Corpus Christi collection. Among the former are three one-fourth to one-third grown, taken respectively Feb. 26, March 20, and July 24. There seems to be very little seasonal variation in color.

This is a well-marked form of the *sylvaticus* group, distinguished by its very small size and the clearer, whitish gray of the sides and rump. I follow Baird in identifying it with the *L. bachmani* of Waterhouse, assuming, with him, that the original specimen was in all probability a part of the "Texas collections

[1] Bull. Am. Mus. Nat. Hist., II, p. 297, Feb., 1890.

of Douglas "—a probability our present knowledge of the southwestern forms of the group (*arizonæ*, *auduboni*, etc.) greatly strengthens. Although this is a light-colored form, it does not present the kind of pallor shown by the pallid forms of the interior.[1]

"All the specimens are from the mainland, where they are not uncommon. I have not found them on the islands, but I am not sure they do not occur there."—H. P. A.

[**Lepus aquaticus** *Bachman.*—Represented by two specimens taken by Mr. Attwater at San Antonio in April, 1891, and one taken May 8, 1894, but there are none in the Aransas County series. I am, however, indebted to Dr. C. Hart Merriam for specimens kindly loaned for examination from Matagorda and the lower Brazos River, showing that the species extends southward from Louisiana along the Gulf coast nearly to Aransas County. The San Antonio specimens are much lighter colored than Dr. Merriam's coast specimens, which do not appear to differ from Louisiana examples.]

5. **Geomys personatus** *True.*—Represented by a series of about 50 specimens, taken nearly throughout the year, only the months of June, July and August being unrepresented.

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[1] An examination in this connection of numerous specimens of the *sylvaticus* group from various parts of North America shows that it stands in need of careful revision. It is an exceedingly plastic group, its representatives varying greatly in size, in color, and particularly in the size of the ears, at different localities. While the material for its satisfactory revision is lacking, I take the present opportunity to characterize a form which attracted my attention many years ago, and was even still earlier referred to by Professor Baird (Mam. N. Am., 1858, p. 599)—namely, a large form from Iowa, Wisconsin and Minnesota, which I propose to call *Lepus sylvaticus mearnsii*, in honor of Dr. E. A. Mearns, U.S.A., on whose large series from Minnesota this subspecies is now primarily based.

Lepus sylvaticus mearnsii, subsp. nov.

Distinguished by its large size and rather pale colors, in comparison with true *sylvaticus* of the East, its nearest ally. The dorsal area is not nearly so dark brown, and the sides of the body are much paler.

Ten specimens from Fort Snelling, Minn., measured in the flesh by Dr. Mearns, average as follows: Total length, 475 mm. (18.74 in.); head and body, 418 mm. (16.45 in.); tail vertebræ, 66 mm. (2.60 in.); hind foot, 105 mm. (3.95 in.). This is about two inches longer in total length than the average of specimens from New York and Massachusetts, while the hind foot is about .30 in. longer.

Compared with the Texas series above mentioned the difference is still more striking, both in respect to coloration and size. Nine Corpus Christi specimens, measured in the flesh by Mr. Chapman, average as follows: Total length, 431 mm. (16.97 in.); tail vertebræ, 45 mm. (1.77 in.); hind foot, 79 mm. (3.11 in.).

Type, No. [illegible], ♂ ad., Fort Snelling, Minn., March 29, 1891, Dr. E. A. Mearns.

This form is somewhat parallel in its large size and peculiar tints with *Tamias striatus griseus* Mearns, *Tamius quadrivittatus neglectus* Allen, *Sciurus carolinensis hypophæus* Merriam, and other forms from the same region yet to be separated.

"This Gopher is very common in Aransas County, especially in that part of the peninsulas between the bay and the edge of the brush. There is hardly a square foot of this belt of land (half a mile to a mile in width), where the soil is sandy and there are few or no trees or brush, that has not been plowed over many times by these animals. I think they have done much towards fertilizing this particular region, and that the wonderful vegetable growth on the knolls and open places on Live Oak, St. Charles and Lamar Peninsulas, can be attributed to this cause.

"Like the Moles, they do not throw up many mounds in summer—from May to September—and probably for the same reason, namely, the abundant food supply of bulbs, roots, etc., which can readily be found within a few feet of their nests. Later they burrow more extensively in search of food. They are particularly destructive to young fruit trees. A farmer on St. Charles Peninsula told me he killed over 250 of these animals between the 18th of March and the middle of April, 1893. They were eating off his young mulberry and pear trees at the roots. The orchard had been set out in an old sweet potato field, and sweet potatoes came up all over it from potatoes left in the ground the previous year. These no doubt attracted the Gophers, as they are particularly fond of sweet potatoes, and are thus a great nuisance to farmers and gardeners.

"Gophers, Pocket Mice and Moles frequent the same localities. I found none of either on any of the islands. They do not take to water, as do the Cotton Rats, Rice-field Mice (*Oryzomys*), Raccoons, etc."—H. P. A.

6. Perognathus paradoxus *Merriam.* TEXAS POCKET MOUSE.

Perognathus fasciatus BAIRD, Mam. N. Am. 1857, 420 (at least in part; not *P. fasciatus* WIED); THOMAS, P. Z. S. 1888, p. 449 (Duval Co., Texas).
Perognathus paradoxus MERRIAM, N. Am. Fauna, No. 1, Oct. 1889, p. 24 (Trego Co., Kansas).
Perognathus paradoxus spilotus MERRIAM, N. Am. Fauna, No. 1, Oct. 1889, p. 25 (Gainesville, Cook Co., Texas); ALLEN, Bull. Am. Mus. Nat. Hist. III, p. 225, April, 1891 (Padre Island and Bee Co., Texas).

This species is represented by 22 specimens, including both sexes and various ages. One was taken in January, 2 in March, 2 in May, 5 in October, 6 in November, and 6 in December.

The adult specimens vary little in color, although some are of a rather stronger shade of reddish yellow than others. Immature examples are darker, with a finer, much softer pelage. They appear to agree perfectly with specimens of corresponding age from Brownsville, Texas.

A large series of adults from Brownsville, taken mostly in August and September, are not comparable as to season, being in thin summer pelage. They are much darker and much less hispid than the Rockport series. An October specimen (No. 4195, ♂ ad.) from Brownsville, however, in nearly full winter coat, is scarcely distinguishable from Rockport examples of corresponding date. Another October Brownsville specimen (4196, ♀ ad.) is less advanced, but plainly indicates a winter pelage like that of the Rockport series.

If separable from the Kansas type (true *paradoxus*), these specimens would all be referable to the *P. paradoxus spilotus* form. The distinctness of the dusky spot on the anterior border of the ear externally is variable, and the whole fore leg is often white instead of tan-colored to the wrist.

"This species is very common in open places, and sometimes where there are bushes. Although found near the shores, I have never met with it on any of the islands. It may, however, occur on St. Joseph Island.[1] Its favorite haunts are the higher knolls in the low flats around the bays. Its chief food in fall and winter is the seeds of the sage weed (*Croton texensis*), which grows in great abundance all over the open country, and affords food for many of the seed-eating mammals and birds. In the spring, when the sage seed becomes scarce, the Pocket Mice take to the seeds of the bur-grass (*Cenchrus tribuloides*), which grows all over this region. On March 29 I caught a half-grown Pocket Mouse with its cheek-pouches filled with these burs. In digging out one of their burrows, probably an old Gopher burrow, I found the bottom of the burrow, for a distance of thirty-five yards, covered with grass burs.

"There are several holes or entrances to each of their homes or nests. The earth removed in excavating them is piled in a

[1] There are two specimens in the Museum Collection from Padre Island.

single mound several feet away. After going into a hole they fill the dirt in behind them, thereby stopping up the entrance, doubtless for the purpose of keeping out snakes. I have never found any nest; perhaps they do not make any, but merely lie in the sand. While they do not appear to lay up large stores, they probably gather food during the night to eat in their holes, laying up a larger quantity for 'northers' or cold spells. They occasionally drag in rubbish with which to close their holes. I once found the wing of a plover dragged into a *Perognathus* hole.

"An old female taken March 31 contained nine very small embryos, but I have never met with any newly-born young. As they eat grass roots, etc., as well as seeds, food is abundant, and they breed early, and probably several times a year.[1] They can be caught in traps baited with oatmeal, and also by placing traps over their holes, so that they are caught in going in or out."—H. P. A.

7. **Mus decumanus** *Linn.* Brown Rat; Wharf Rat.—"Captain Bailey, Captain Phillips, and several other old settlers say that 'Barn Rats' or 'Wharf Rats' were abundant fifteen to twenty years ago, but that they gradually disappeared after the great beef packing establishments closed up, and the marine shipping ceased upon the advent of the railway into this region. I do not believe there is at present a Brown Rat in Aransas County. I failed to find one during my two years' residence there, in 1892 and 1893."—H. P. A.

Mr. Chapman secured a very large specimen of this species in the vicinity of Corpus Christi.

8. **Mus alexandrinus** *Goeffr.* White-Bellied Rat; Roof Rat.—One specimen, ♂ ad., Feb. 20, 1893.

"The specimen sent was caught on a boat which made trips between St. Charles Peninsula and Rockport. Lucas Dubois, the captain, said it had been on the boat about a year before he caught it. I have heard of rats being killed on other boats here, but they may have been of other species."—H. P. A.

[1] There are half-grown young in the collection taken August 14 (at Brownsville), and as late as Oct. 20 and Nov. 15 (the last two at Rockport).

9. **Mus musculus** *Linn.* House Mouse.— Eleven specimens, part caught in the house and part in the fields. They vary much in color, particularly on the ventral surface, as house mice are apt to do at other localities. Two are dingy reddish gray below ; one is nearly pure white ; others are grayish white tinged with buff, and one is strong reddish buff. Age and season doubtless have much to do with this variation, but it is doubtless largely purely individual.

11. **Neotoma micropus** *Baird.* Texas Wood Rat.— Eleven specimens of this species include specimens taken in January, March, June, September, October and December. Three belonging to one litter and less than one-fourth grown, were taken March 30. These are clear ashy gray above washed with black, the prevailing color of the middle of the dorsal area being deep black.

There is little to add to the account of this species already given.[1] The Museum has now large series from Brownsville, Corpus Christi, and Rockport. Several of the Rockport (June and September) specimens have the pelage of the posterior parts of the body very much abraded.

"Common on the main land wherever bunches of Opuntia are growing, but I have not found them on any of the islands. They may, however, occur on St. Joseph Island. I caught one under a wharf, near the water's edge, in the main part of the town of Rockport, in a trap baited with sweet potato. Capt. N. C. Phillips, an old settler, says these rats are excellent eating, in his estimation far superior to squirrel meat.

"I found a nest once in a club house on Copano Bay, used in the hunting season by duck hunters. A pile of all kinds of material had been carried in, and a nice round nest, open on the top, made in the middle of it."—H. P. A.

12. **Sigmodon hispidus texianus** (*Aud. & Bachm.*). Texas Cotton Rat.—This species is represented by a series of 42 specimens, taken between Sept. 30 and March 30, the other

[1] This Bulletin, Vol. III, pp 282–285, June, 1891.

months of the year being unrepresented. They fall into two quite sharply differentiated phases—a blackish-gray phase, slightly varied with pale yellowish brown, and a yellowish-brown series, slightly varied with blackish. If they came from widely separated localities they might easily be taken for well-marked geographical forms. Mr. Chapman's Corpus Christi series of 10 specimens is separable in the same way, as he has already noted (this Bulletin, V, p. 45). In this case Mr. Chapman states that the dark specimens came from the marshes, where their runways "led beneath the dense mat of marsh grass," and the light specimens from the dry, scrubby chaparral, where they were more exposed to the bleaching effect of the sunlight. In view of Mr. Chapman's experience I wrote to Mr. Attwater for definite information as to the kind of ground in which the specimens were taken. In reply he states that *all* the specimens came from the islands, where the highest ground—an old railway bed—is "only five feet above the water-line of the bays, and the highest natural level only three feet, the average being about two feet. At high tides much of the land is flooded. The entire location was cut up with channels and bayous, and on the whole would be properly described as a *damp* situation. The rats made their homes on the higher spots in half-flooded situations, generally along the sides of the railway 'dump,' but no part of their haunts could be compared with the 'dry scrubby chaparral.'" In this case therefore it would seem that the two phases above mentioned simply represent individual variation assorted in accordance with the tints of the pelage into two series! Yet there are comparatively few well-marked 'intergrades.'

Ten adults, as measured by the collector, give the following: Total length, 258 to 308 mm., averaging 282; head and body, 137 to 174, averaging 156; tail vertebræ, 110 to 133, averaging 126[1]; hind foot, 31 to 33, averaging 32.

Six adults from Corpus Christi, measured in the flesh by Mr. Chapman, give the following: Total length, 264 to 290, averaging 277; head and body, 145 to 180, averaging 170; tail vertebræ, 97 to 121, averaging 109[1]; hind foot, 30 to 33, averaging 31.5.

[1] The discrepancy in the relative length of the tail in these two sets of measurements is doubtless due to different methods of measuring, as regards the starting point for taking the length of the tail.

As regards seasonal variation, November and December specimens average darker than those taken in other months, while the March specimens are much the lightest of the series. As previously stated, the months of April to August, inclusive, are unrepresented.

" *Sigmodons* are common on the group of small islands (marked No. 2, No. 3 and No. 4 on the map I send you), particularly so on Island No. 2, and at the 'Point' or 'Pocket' where *Oryzomys* was found. I have found none on the mainland. They may occur on St. Joseph Island, as they are good swimmers. Their favorite haunts are the thick growths of cacti (*Opuntia*), and the thick matted grass that grows near the water's edge. They have been found living with *Oryzomys* and *Onychomys* in the bunches of cactus. Their nests are usually placed on the ground among cactus roots, or under piles of brush, and among the roots of the dwarfed huisache bushes, and are usually composed of anything handy. One nest was made entirely of hog bristles, taken from a dead hog lying near a bunch of cactus. When disturbed they retreat into shallow holes in the ground. They are much preyed upon by rapacious birds and mammals—by the marsh hawk in the day time and by the short-eared owl at night. A great many are also captured by rattlesnakes, and probably also by raccoons and skunks."—H. P. A.

13. **Oryzomys palustris texensis,** subsp. nov.

Above very pale yellowish gray-brown, varied with blackish over the middle of the dorsal region, forming an indistinct blackish dorsal band ; sides yellowish gray, very slightly varied with blackish tipped hairs. Below clear grayish white, the fur plumbeous at base.

Total length (of type, No. $\frac{7168}{5764}$, ♂ ad., Rockport, Texas, Nov. 15, 1893, H. P. Attwater), 277 mm. ; head and body, 137 ; tail vertebræ, 140 ; hind foot, 30.5.

Seven adult males give the following, based on the collector's measurements taken from the fresh specimens : Total length, 249 to 280, averaging 264 ; head and body, 122 to 146, averaging 131 ; tail vertebræ, 122 to 140, averaging 132 ; hind foot, 28.5 to 30.5, averaging 30.

This is simply a large pallid form of the *O. palustris* group. The Rockport series, when compared with Louisiana and Florida specimens of *O. palustris natator* Chapm.,[1] is strikingly different in coloration, about as different, and differing much in the same way, as the Brown Rat (*Mus decumanus*) and the Muskrat. The color differences are much less when the Rockport series is compared with North Carolina specimens (true *O. palustris*), but are still very appreciable, while the size is much larger. The following comparative measurements indicate the average size of the three forms (measurements in millimetres):

	No. of Specimens.	Locality.	Total length.	Tail.	Hind foot.
O. palustris.[2]	5 ♂	Raleigh, N. C.....	237	120	30
O. p. natator[2]	5 ♂	Gainesville, Fla....	286	136	33
O. p. texensis.....	7 ♂	Rockport, Texas...	264	132	30

This is doubtless the large pale form mentioned by Dr. Coues (Mon. N. Am. Roden., 1877, p. 116) as occurring at Neosho Falls, Kansas. All of the *Oryzomys* thus far examined from Brownsville, Texas, have proved to be *O. aquaticus*—a very different species from any form of the *O. palustris* group. On the other hand, Corpus Christi (Chapman, l. c., p. 45) and Rockport specimens have all proved referable to what is here named *O. p. texensis.*

The Rockport series numbers 29 specimens, and includes young of various ages, middle-aged specimens, and eight or ten that are fully adult. Two were taken in March, one in January, and the rest between Oct. 4 and Dec. 5. One (No. 65, Coll. H. P. Attwater) is exceptionally rufescent; this is the single example mentioned by Mr. Chapman (l. c., p. 45) as apparently referable to his *O. p. natator.*

"The specimens were all taken at one locality, and nearly all from the 'Point' or 'Pocket' near the mainland [see Map, p. 166]. Some of them were found in holes in the shell ridge formed by the abandoned railway bed, where the *Sitomys mearnsii* were taken. In fact, they made nests in the holes I had formed on former visits in digging out *S. mearnsii.* They were much

[1] *Cf.* Bull. Am. Mus. Nat. Hist., V, p. 44, March 17, 1893.
[2] *Cf.* Chapman, l. c., p. 44.

more common in 1893 than in 1892. I think they move about somewhat, as I have found them in places where I had vainly searched for them a short time before. Their favorite resorts are places where the Spanish bayonet (*Yucca*, sp.) grows. They make many nests among the leaves of this plant, placing them close to the stem, beneath the dead leaves, which hang down and afford them shelter. They also nest in holes in the shell ridges. In most cases I have found the male and female in the same nest, but in the yuccas and among the prickly pears, the males and females appeared to occupy separate nests. They also live in the piles of sea weed which accumulate along the beach. Favorite places for them are the 'duck-blinds' made by the hunters for concealment in duck shooting. I once heaped together a small pile of yucca and weed stalks, and used to find one or two of these mice under it whenever I visited the place, during October and November. They eat all kinds of weed seeds, and are very fond of the seeds of the prickly pear."—H. P. A.

14. Sitomys mearnsii (*Allen*). MEARNS'S WHITE-FOOTED MOUSE.

Vesperimus mearnsii ALLEN, Bull. Am. Mus. Nat. Hist. III, p. 300, June, 1891 (Brownsville, Texas).
Sitomys mearnsii BRYANT, Zoe, III, Oct. 1892, p. 214.

Represented by a series of 26 specimens, including adults and young of various ages, and also by several nests, collected mainly between Oct. 2 and Jan. 2. As a series they differ very appreciably from a similar series from Brownsville, collected chiefly in August and September. The two phases are evidently too close, however, to require separation. There is practically no difference in size or proportions, judging by the measurements taken by the collectors from the fresh specimens, the slight discrepancy in the relative length of the tail being doubtless due to different methods of measuring. Thus, 14 adult specimens from Brownsville give the following averages and extremes: Total length, 175 to 182 mm., averaging 177; head and body, 89 to 105, averaging 97; tail, 74 to 85, averaging 80; hind foot, 19 to 22, averaging 20. A series of 12 adults from Rockport gives the following: Total length, 160 to 190, averaging 172; head and body, 76 to 101, averaging 84; hind foot, 19 to 21.5, averaging 20.

In coloration many of the specimens are indistinguishable, but as a series the Rockport specimens are slightly more rufescent, several of the specimens shading much more strongly toward chestnut than any in the Brownsville series. Several Bee County specimens,[1] it is of interest to note, are all as strongly chestnut as the brightest Rockport specimens. One-third of the Brownsville specimens show some trace of a rufescent pectoral spot, while in one-fourth of them it is quite strongly defined, but in the Rockport series not one shows the slightest tendency to such a spot.

"Most of these mice were taken from nests placed in holes in the slopes of an abandoned railway embankment. They are found, however, elsewhere, and even enter houses, where they live with common house-mice, specimens of both having been taken at the same time in the same room.

"The various nests obtained were placed in the sloping railway embankment, at the end of a horizontal burrow, from six inches to two feet in length. Often there is also a vertical exit to the top of the level ground, so that after digging in to the nest one finds that the mouse has escaped up through the other hole. No attempt is made to conceal the entrance. The nests are generally made of anything handy, generally of sea moss, and occasionally of fine grass, or tow, the latter obtained by gnawing up old pieces of rope or twine found on the beach. The breeding season is so arranged that the young are born about the time the seeds of various weeds, on which they feed, begin to ripen. Before the young are born a male and female will be found occupying the same nest, but after this event the male will be found in another hole not far away. Four to six is the usual number of young in a litter. I have several times taken the old female and her young ones home with me to try and raise them, but in a day or two the young ones began to die. On one occasion (Oct. 2) I caught a male and female in separate holes and put them

[1] These were formerly incorrectly referred to "*Vesperimus leucopus texanus*" (= *Sytomys americanus texanus*). *Cf.* Bull. Am. Mus. Nat. Hist., III, p. 224, April, 1891. The *texanus* phase is quite different.

together in a box alive. During the night young were born, of which three were found in the box the next morning, and the remains of one or two more, in the stomach of the male. At another time a male and female, the latter having newly-born young, were put in a box, and in the morning it was found that the male had killed and eaten two of the five young ones.

"I have never seen any fawn-colored spot on the breast of any *Sitomys* found in this locality."—H. P. A.

15. **Sitomys (Baiomys) taylori** (*Thomas*). TAYLOR'S MOUSE.—One specimen, ♂, Oct. 19. Apparently a rare species near Rockport.

"Brought to me by a boy, who said he found it while digging Wood Rats out of a bunch of prickly pear."—H. P. A.

16. **Onychomys longipes** *Merriam.*[1] TEXAS GRASSHOPPER MOUSE.—Six specimens, March and December, including adults and young. Identified as this species by Dr. Merriam.

"This species I found least common of any of the small mammals. They are much slower in their movements than *Sigmodon*, *Oryzomys*, and others, and probably for this reason get picked up by hawks, owls, skunks, etc. Two young specimens were caught in traps set over *Perognathus* holes. They probably wander around, looking into holes and crevices for beetles and other insects, and may find many 'square meals' in the *Perognathus* entrances. All were found at the 'Point' close to the mainland, which is surrounded most of the time by mud and water. Two, male and female (probably a pair), were dug out of a shallow hole in the ground among the roots of some dwarfed huisache bushes, and another among the roots of *Opuntia*. At one of these places I found several hundred wings of butterflies [*Danais archippus*], the bodies of which had been eaten by the *Onychomys*.[2] Wings of these butterflies were often found scattered all over this particular locality. These butterflies [identified as above from specimens sent by Mr. Attwater] appear to be migratory, coming here by thousands in the fall."—H. P. A.

[1] N. Am. Fauna, No. 2, Oct., 1889, p. 1. Concho Co., Texas.

[2] This observation is of special interest from the fact that this butterfly is supposed to be 'protected' by a nauseous odor or taste that renders it unpalatable to animals.

17. Spermophilus mexicanus (*Licht.*). MEXICAN SPERMOPHILE.— Four specimens, Oct. 3, 1893.

"These specimens were sent to me from some place near Gregory, between Corpus Christi and Rockport. They are not nearly as numerous in Aransas County as they are about Corpus Christi. I hear of a few in the Black Jack Peninsula, and occasionally near Rockport, but they are quite scarce."—H. P. A.

Mr. Frank M. Chapman collected a series of nine specimens at Corpus Christi, April 8–11, 1891, where he found them locally abundant along the coast, but apparently absent in the interior. Aransas County seems to form their northern limit of distribution in the coast region of Texas.

The type of *Spermophilus mexicanus* came from Toluco, near the City of Mexico. In the absence of material from the type locality the Texas specimens are provisionally identified as above.

Five adult males in Mr. Chapman's series give the following average measurements, taken by the collector before skinning: Total length, 304 mm.; head and body, 188; tail, 116; hind foot, 40. The Corpus Christi specimens do not differ appreciably from a large series from Brownsville.

18. Spermophilus spilosoma annectens *Merriam.*[1] PADRE ISLAND SPERMOPHILE.—One specimen, Mustang Island, near Aransas Pass, 12 miles from Rockport, Oct. 26, 1893; 4 specimens, same locality, April 25, 1894. These latter have been submitted to Dr. Merriam for examination, who finds them to agree with his Padre Island series.

"Spermophiles are said to be very common on Mustang Island. I sent over for specimens, and No. 129 [as recorded above] was sent to me. It was killed near the life-saving station [at the north end of the island]. I am told they are found all over Mustang Island, but there are none on St. Joseph Island, nor can I hear of any ever having been found there."—H. P. A.

Mustang Island is practically a continuation of Padre Island, the type locality of this subspecies, although at present separated

[1] Proc. Biol. Soc. Washington, VIII, p. 132, Dec. 28, 1893.

from it by a narrow inlet only a few miles in width. St. Joseph Island, only slightly separated from Mustang Island, is a further continuation of the remarkable series of 'sand-spits,' or low, narrow, sandy islands, that extends from near the mouth of the Rio Grande north to Matagorda Bay, and is continued still further in the narrow Matagorda Peninsula. Apparently Mustang Island forms the northern limit of distribution of this peculiar form of Spermophile.

19. **Sciurus niger limitis** (*Baird*). TEXAN FOX SQUIRREL.— One specimen, ♂ ad., Rockport, Feb. 27, 1893. Not appreciably different from a specimen from the type locality (San Pedro or Devil's River) of Baird's *Sciurus limitis*, recently received from Dr. E. A. Mearns.

"There are no Fox Squirrels in Aransas County except on St. Charles Peninsula, where there are several square miles of black-jack oaks. This area is separated from the timber on the Guadaloupe River by prairie land, so that this colony of Fox Squirrels is practically isolated."—H. P. A.

20. **Dicotyles angulatus** *Cope.*[1] PECCARY.—"Formerly common in Aransas and adjoining counties, but now rarely met with. On Aug. 20, 1892, a large male was killed in front of the Bay View Hotel on the beach in the city of Rockport. It was in the shallow salt water, rooting among the sea grass. It was a season of great drouth, and I fancy the dry weather may have had something to do with its wanderings."—H. P. A.

21. **Bison americanus** (*Gmel.*). AMERICAN BISON.—"I have been told by old residents that the horns and bones of this animal were formerly found on the prairies of Aransas County."— H. P. A.

22. **Cariacus virginianus** (*Bodd.*). VIRGINIA DEER.— There are no specimens in the collection, and the following note is therefore provisionally assigned to this species.

[1] Am. Nat., XXXIII, p. 147, Feb., 1889.

"Rare on the peninsulas, but quite numerous on St. Joseph Island, where they are protected by Messrs. Wood and Allyn, who own the island and use it as a cattle and sheep ranch. Captain Bailey informs me that about 1857 or 1858 thousands of deer died throughout this region from a disease called the 'black tongue,' on account of the tongues in the dead animals being found to be black."—H. P. A.

Note on the Camels introduced into Texas.—As is well known, the United States Government introduced, many years since, two shipments of Camels[1] into Texas, with a view to their acclimatization and use for military purposes. Mr. Attwater made casual reference to the matter in his notes, and on applying to him later for more definite information, he has obtained and kindly transmitted an important letter, written at his solicitation, by Capt. C. F. Bailey, an old settler and prominent citizen of Rockport, from which the following interesting extracts are taken. According to 'Reports upon the Purchase, Importation and Use of Camels and Dromedaries, to be employed for Military Purposes, according to Act of Congress of March 3, 1855,' made by Major Henry C. Wayne (published as Senate Ex. Doc. No. 62, 34th Congress, 3d Session, 1857), it appears that the first shipment, consisting of 34 animals, was landed at Indianola, Texas, May 13, 1856, and the second, of 41 animals, at the same port, Feb. 10, 1857. Says Capt. Bailey: ".... I personally saw about half-a-dozen of these camels myself during the year 1863 .... After landing the camels were loaded only once for the upper country [San Antonio], and then returned to the coast, when the war broke out, and the Confederate authorities not wishing to be bothered with them turned them loose, particularly as the Arabs who had been brought out to manage them had also left. They wandered and scattered without control, let or hindrance all over the country from the Nueces to Indianola, and from San Antonio to the Gulf, with never more than two or three in a bunch. I never heard of but one being killed, and that was on the Aransas River. He was a particularly ugly old male, would pursue and attack every one he saw, whether mounted or

[1] There appear to have been several Dromedaries in the first shipment.

on foot, and was killed by a party on horseback he was pursuing. The last I ever heard of any of them was that a stockman gathered all he could find, either seven or eight, and sold them to the manager of a circus that was traveling through the country, as every body sold every body's else cattle in those days, to be paid for if claim was ever made. It is safe to say that no claim was ever made. This sale was in 1867, I think. Whatever became of the majority of them no one can ever positively tell. I never heard of but one young one being born in this country. An old female with a young one following her was seen near Indianola in 1860 or 1861. I do not think it ever grew to maturity."

23. **Atalapha noveboracensis** (*Erxl.*). RED BAT.—Five specimens, Rockport, August and September, 1893.

As I have elsewhere stated,[1] there is a well-marked sexual difference in color in the present species, the females being darker and duller than the males, with the whitish tipping of the hairs broader, giving a very different general effect to the coloration.

"The only bats I found were the red ones I sent you. I think they stay around trees and roost in them. Captain Phillips informs me that he has noticed also a small brown bat."—H. P. A.

It may be worth while to record in this connection the capture of *Atalapha cinerea* (Beauv.) from Texas, there being in the collection of the American Museum a specimen from Brownsville (Oct. 24, 1891, F. B. Armstrong), and another from probably Bee County (exact locality uncertain), presented by Mr. George B. Sennett.

There is also in the Museum a series of six specimens of *Dasypterus intermedius* (H. Allen) from Brownsville, Texas (March 17–19, May 28–30, Aug. 29, F. B. Armstrong), where it is apparently not uncommon.

24. **Scalops texanus** *Allen*. TEXAS MOLE.

Scalops argentatus texanus ALLEN, Bull. Am. Mus. Nat. Hist. III, p. 221, April, 1891.
Scalops texanus ALLEN, *ibid*, V, p. 200, Aug. 1893.

[1] Bull. Mus. Comp. Zoöl., I, No. 8, Oct., 1869, p. 207.

This species is represented by a series of 26 specimens, collected by Mr. Attwater in the vicinity of Rockport. They vary considerably in coloration, independently of age, sex, or season, mainly in the amount of orange suffusion pervading the pelage. A few specimens show it in comparatively slight degree; in others it is very strong, so that when held from the light the anterior half of the ventral surface is often deep chestnut orange. The head, and sometimes the anterior third of the dorsal surface, is usually much more fulvous than the rest of the upper surface. There is generally a well-defined orange spot on each side of the nose, the two spots sometimes uniting across the base of the forehead.

The collector's measurements of 12 adult males give the following extremes and averages: Total length, 135 to 147 mm., averaging 141; tail, 23 to 27, averaging 25; hind foot, 16.5 to 19, averaging 17.8. Eight females average slightly smaller, as follows: Total length, 132 to 146, averaging 137; tail, 20 to 25.5, averaging 23; hind foot, 15 to 18, averaging 16.5.

"Moles are very numerous all over the peninsula, perhaps the most common of any of the small mammals. They are extremely hard to catch, frequently going around and under the trap. They work chiefly at night, and go sometimes two or three hundred yards to find a good feeding place. They are particularly active after a rain, the rain probably having something to do with the movements of the insects on which they feed.

"Mole runways are very common even in parts of the country where the soil is very poor, apparently nothing but sand, and the vegetation consists of shrubby oaks and sweet bays, and where no other small mammals are found. But they are most numerous where the soil is more or less damp, as in the so-called 'sub-irrigated' lands, where the dampness comes nearly to the surface. During very dry weather the moles descend deeper into the ground, as owing to the dryness of the soil the runways then fill by the crumbling sand when near the surface. They appear also to be more active in the fall, spring and winter months than in summer, when, from the greater abundance of insects, they may be able to procure food with less effort.

"The position selected for the nest is several feet below the surface, and always in a hard place to get at, being generally under a clump of bushes or a tree. A nest I dug out was made of fine grass. I have never seen any young ones, nor caught any that were very small."—H. P. A.

25. **Procyon lotor hernandezii** (*Wagler*).—One specimen, from Corpus Christi (April 10, 1891, F. M. Chapman). There are no specimens in Mr. Attwater's collection, but he reports it as abundant, writing as follows:

"Raccoons are common on the peninsulas, and very abundant on St. Joseph Island. George Roberts killed 125 on this island during the winter of 1892–93, and W. A. Brundrett sold 175 'coon' skins taken on Matagorda Island, the next island to the east of St. Joseph, and in the next county. They live in the long grass in the marshes on the side nearest the bays, and in the chaparral on the ridges. Their food consists chiefly of crabs, shell-fish, dead fish washed on the shores, wounded ducks and other birds, birds' eggs, berries, etc. I have not had an opportunity to put up a series of specimens, but have seen a number of skins, which appear to me to be lighter in color, and as a rule much more yellowish than those which are found further inland." —H. P. A.

26. **Bassariscus astutus** *Licht.* Civet Cat.—Not represented in the collection.

"One was killed in Aransas County last year, and I have heard of several others being taken on St. Charles Peninsula. They are very common in the counties to the north and west, and do considerable damage by destroying chickens while roosting in the trees around the ranches.

"Captain Robert Strachan, who has charge of the main wharf at Rockport, has a pet Civet Cat which has been loose in the warehouse for about two years. It often comes and eats out of his hand. It drinks milk, and will eat cheese, meat and fish (cooked and raw). He says there were a few rats in the warehouse when he first got the Civet Cat, but it soon cleared them out. It disappeared once for several months, but returned again. It was caught in Bee County."—H. P. A.

27. Conepatus mapurito (*Gm.*).—This species is represented by two skulls. Mr. Attwater refers to a mounted specimen in his collection, and speaks of the species as less common even than the Little Striped Skunk. The specimens sent were taken in the outskirts of the town of Rockport.

28. Mephitis mesomelas *Licht.* TEXAS SKUNK.

Mephitis mesomelas LICHT. Darst. neuer oder wenig bekannter Säug. 1827-34, Taf. XLV, fig. 2, and accompanying text ("Louisiana"); BAIRD, Mam. N. Am. 1857, p. 199 (based on above).
Mephitis varians GRAY, Charlesworth's Mag. Nat. Hist. I, 1837, p. 581 (Texas; from Mr. Drummond's Coll.); List Mam. Brit. Mus. 1843, 69 (same; in part only, of Gray's later papers); BAIRD, Mam. N. Am. 1857, p. 193 (Texas); Zoöl. Mex. Bound. Surv. Mamm. 1859, p. 19 (Texas and N. E. Mexico).
Mephitis macroura AUD. & BACH. Quad. N. Am. III, 1853, p. 11, pl. cii (San Antonio, Texas; not *M. macroura* Licht.).

Two specimens, ♂ and ♀, Rockport, March 23 and Oct. 20, 1893. They agree very closely with a series of 12 adult specimens from the late 'Neutral Strip,' now part of Oklahoma, collected by Messrs. Richardson and Rowley on the Museum Expedition of 1889.

These 14 specimens are very uniform in coloration and size, there being no noteworthy variation in the whole series. Moreover, in style of coloration, in size and relative proportions, they agree closely with the figure and measurements given by Lichtenstein (l. c.) for his *Mephitis mesomelas*. Lichtenstein refers to a single example in the Berlin Museum, on which the species was based, as having been received from a dealer, with the statement that it came from "Louisiana." How long it had been in the Museum when he wrote, and whether it came from the present State of Louisiana, or from the Louisiana of early days, are matters now impossible to determine. The probability that the Skunk of eastern and northern Texas ranges eastward into western Louisiana, as well as northward to Oklahoma, and that the original specimen of Lichtenstein's *M. mesomelas* is quite likely to have come from some part of this area, coupled with the fact that almost any one of the dozen Oklahoma specimens before me might have served as the basis of his description and figure, seems to render desirable the adoption of Lichtenstein's name for the species here under consideration.

The characters of this species may be indicated as follows:

Size large; tail long, full, broad and bushy, rather squarely truncated at the end, the vertebræ alone about half the length of the head and body. Total length, 725 mm.; head and body, 408; tail vertebræ, 252; tail to end of hairs, 317 (average of 8 adults from the 'Neutral Strip'; measurements from skins). General color black, with the usual white frontal stripe very narrow and not reaching the white patch on the nape; nuchal patch broad, square in front, narrowing posteriorly to the interscapular region, where it is usually much narrower than at the front border; slightly behind the shoulders it divides into two broad lateral bands which pass, one on each side of the body, on to the basal portion of the tail; between these is a median dorsal band of usually about the width of one of the lateral white stripes, and is continued over the basal half or two-thirds of the tail. The tail hairs are all white basally and black apically, except a few that are wholly white. The latter vary in number in different specimens, being few in some but generally numerous enough to form conspicuous tufts along the sides of the tail, and generally also on the dorsal surface, where at the base of the apical third they often form a more or less pronounced whitish spot, or even a well-marked white band. About half the specimens show a pair of small, oval, symmetrically arranged spots of white on the breast. There is no pencil of white in the tip of the tail, which is wholly black, thick, and obtusely truncate at the end.

Lichtenstein's description, as already said, is strictly pertinent to the present animal. His measurements, translated into millimeters, are as follows: Total length, 731 mm.; head and body, 432; tail vertebræ, 229; tail to end of hairs, 299. Compared with my average for 8 Oklahoma specimens, the difference is practically nothing—not greater than occurs between different individuals of the Oklahoma series.

One of the two specimens in Mr. Attwater's collection is practically identical with several of the Oklahoma specimens; the other is similar except that the amount of white is much reduced, the frontal stripe being narrowed to a line of scattered white hairs; the nuchal patch is also narrower and much shorter, dividing in front of the shoulders into two very narrow lateral stripes, which disappear entirely in front of the hips. Also only a very few scattered white hairs reach the surface of the tail. Mr. Attwater states in his notes that in Aransas County this Skunk "varies much in color, some being very white, and I have been told that pure black ones have been killed." He further states that it is the common Skunk of Aransas County, being far more numerous than either of the other two species.

This species differs from the eastern *M. mephitica* in being rather larger, apparently in greater constancy of coloration, and in the posterior extension (ordinarily) of the lateral white stripes on to the basal third of the tail. It also varies in cranial characters, the skull being relatively narrower and longer, with the zygomatic arches less expanded, but especially in the much heavier dentition. Thus the length of the lateral tooth line to the basilar length of the skull is as 37 to 100, while in *M. mephitis* it is as 34.5 to 100. The ratio of breadth across the last molars to basilar length is as 46 to 100, as against 43 to 100 in *M. mephitica.*

Compared with *M. estor* Merriam, from Arizona, *M. mesomelas* is much the larger, the skull averaging 6 mm. longer in basilar length, and 5 mm. wider in zygomatic breadth. Both belong to the western section of the genus, characterized by heavy dental armature, as compared with the Skunks from east of the Great Plains. Several Minnesota specimens agree very well in size and coloration with *M. mesomelas*, but agree with eastern specimens in their weaker dental armature and correlated cranial modifications.

Having spent considerable time in measuring a large series of skulls of the genus *Mephitis*, in the present connection, I append the accompanying tables of results, including averages and ratios of about 34 specimens, believing it may have some interest to other students of this troublesome group.

In explanation of the tables it may be added that the proportion of very old skulls is very small, and all obviously undergrown specimens were excluded; "juv" in the table simply means 'young adult.' Where the sex sign is followed by an interrogation mark, the specimen was received without the sex being indicated by the collector, but in each case the sex as given in the table is almost beyond question correct. The three Minnesota specimens are all very old, which may in part account for their very large size, as compared with any others in the series, although they probably indicate a large form of the *M. mephitica* group.

The second table is an abridged summary of the first, on which it is based, giving most of the elements of real value, and omitting many that are practically worthless. As in the case of Dr.

MEASUREMENTS AND RATIOS.	*Mephitis mesomelas.* Neutral Strip, Oklahoma.								
	No. 3025	No. 3027	No. 4601	No. 4602	No. 3740	No. 4334	No. 3026	No. 3029	No 302
MEASUREMENTS.	♂ ad.	♂ juv.	♂? ad.	♀? ad.	♀ ad.	♀ ad.	♀ ad.	♀ juv.	♀ ad
Occip. condyle to ant. bord. premax	74.0	71.5	71.2	66.0	64.0	67.0	67.5	66.0	69.
Occip. crest to ant. bord. nasals	70.0	66.0	68.0	63.0	62.0	64.5	65.0	63.0	64.
Basilar length (Hensel)	66.0	63.2	63.5	59.0	58.0	59.5	59.5	58.0	60.
Greatest zygomatic breadth	46.0	45.0	43.3	42.0	43.5	41.8	44.0	42.0	43.
Greatest mastoid breadth	38.5	38.0	38.2	36.0	34.5	36.0	38.0	35.0	36.
Least postorbital breadth	19.0	20.0	20.6	18.5	19.0	20.0	19.0	18.0	19.
Foram. mag. to post. bord. palatals	38.5	37.2	36.0	34.0	34.5	33.2	35.0	33.0	35.
Length of palatal floor	27.5	27.0	28.0	28.0	25.0	27.0	25.0	26.0	26.
Length of pteryg. fossa (base of ham proc. to post. bord. palat.)	16.5	16.2	16.0	15.0	13.5	15.3	16.0	13.0	16.
Height of cranium at basisphenoid	23.5	22.0	23.0	23.0	22.0	23.0	23.0	23.0	21.
Height of cranium at postorb. proc	22.0	23.7	23.7	24.0	22.0	22.0	22.0	20.0	21.
Length of tooth-row (at alveoli)	24.0	23.5	23.8	24.0	21.3	22.2	22.3	22.5	23.
Length of incisor tooth-row	11.0	11.7	10.6	10.0	10.0	10.0	11.0	10.0	11.
Distance between ext. bord. last molars	30.0	29.0	27.0	27.0	27.0	27.0	27.0	26.5	27.
Distance between ext. bord. canines	19.5	18.0	18.2	18.0	17.0	17.0	18.0	17.0	16.
Length of mandibular ramus	50.0	48.5	48.5	44.0	45.0	46.5	46.0	44.0	46.
Height of mand. ramus (angle to cor. proc.)	26.0	24.6	24.0	21.0	22.3	21.0	22.0	21.0	22.
RATIOS *to Basilar length* (*Hensel*).									
Zygomatic breadth	69.7	71.0	68.2	71.2	75.0	70.3	74.0	72.4	71.
Mastoid breadth	58.5	60.1	60.2	61.0	57.8	62.0	64.0	60.4	59.
Length of palatal floor	41.7	42.7	44.1	47.5	43.1	45.4	42.0	44.8	43.
Distance from foram. mag. to post-palatal border	58.5	59.0	56.7	57.6	59.5	55.8	59.0	56.9	57.
Length of lateral tooth-row	36.2	37.2	39.1	40.7	36.7	37.3	37.5	38.8	37.
Breadth across molars	45.5	45.9	42.5	45.8	46.5	45.4	45.4	45.7	44.

Merriam's much more detailed table of measurements of skulls of the genus *Spilogale* (N. Am. Fauna, No. 4, Oct., 1890), to quote from his remarks on the subject: "Many of the measurements, and more of the ratios, are worthless; and the table is published as much to show these as those which are really important" (l. c., p. 4). Although my tables give a much larger number of skulls per species than his, they are still too few to give satisfactory results, the addition of a single skull to a series of five or six being often found to modify some of the averages quite materially.

II.—Summary of Measurements and Ratios.

MALES.

Measurements.					
Number of specimens	3[1]	3[2]	4[3]	6[4]	1[5]
Basilar length	62.1	69.3	63.5	58.7	66.0
Zygomatic breadth	44.6	50.0	46.6	61.8	46.0
Mastoid breadth	36.2	44.3	40.8	36.0	40.0
Lateral tooth-row	22.6	23.6	22.0	21.5	23.0
Breadth across molars	28.7	27.2	27.2	25.9	30.0
Ratios *to Basilar Length.*					
Zygomatic breadth	71.8	72.2	73.5	71.2	70.0
Mastoid breadth	61.5	63.9	64.3	61.3	60.0
Foramen mag. to palatine notch	60.0	57.9	56.5	56.9	56.0
Length of palatal floor	44.3	42.0	43.5	43.1	43.0
Lateral tooth-row	36.4	34.0	34.7	36.8	34.9
Breadth across molars	46.2	42.4	42.8	44.2	45.5

FEMALES.

Measurements.				
Number of specimens	6[1]	4[3]	6[4]	1[5]
Basilar length	59.1	59.2	55.9	61.0
Zygomatic breadth	42.8	43.2	40.5	45.0
Mastoid breadth	35.9	36.7	34.7	40.3
Lateral tooth-row	22.6	21.9	21.3	23.0
Breadth across molars	26.9	26.4	25.2	28.0
Ratios *to Basilar Length.*				
Zygomatic breadth	72.6	72.9	72.4	73.8
Mastoid breadth	62.6	61.9	61.0	66.1
Foramen mag. to palatine notch	57.7	57.6	57.7	57.4
Length of palatal floor	44.5	43.5	45.3	43.1
Lateral tooth-row	38.2	37.0	38.1	37.7
Breadth across molars	45.5	44.6	44.8	46.0

[1] *Mephitis mesomelas*, Oklahoma.
[2] *Mephitis mephitica*, Ft. Snelling, Minn.
[3] *Mephitis mephitica*, Ohio, Indiana and New York.
[4] *Mephitis estor*, Arizona.
[5] *Mephitis occidentalis*, British Columbia.

In regard to these measurements it may be said that females, as was well enough known before, average slightly smaller than the males ; they also prove to have, as a rule, a shorter mandibular ramus and a lower coronoid process, while the inter- and post-orbital regions of the skull are perhaps relatively slightly broader. In some cases individual variation nearly overlaps the sexual, but generally the differences in size and proportions in skulls from the same locality furnish a trustworthy clue to the sex of the specimens ; but in specimens of unknown origin from widely separated localities, it might be difficult to tell northern males from southern females, when both are specifically the same, there being apparently a marked decrease in size southward in all of the species.

Again, the difference in size and proportions is so slight in the different forms of the genus, and the range of individual variation so great, that perhaps no single character may be taken as invariably diagnostic, although the difference in the relative size of the teeth as compared with the rest of the skull will suffice to distinguish an eastern skunk from a western skunk, and the difference in general size will serve to give some clue to the habitat.

Note on the variability of coloration in the Skunks of the genus MEPHITIS.—In 1869 I referred to the common Skunk of the northeastern United States as one of the most variable animals, as regards coloration, to be found in North America, and described at length (Bull. Mus. Comp. Zoöl., I, No. 8, p. 179) the great amount of variation to be met with in Massachusetts specimens. This was apropos of Prof. Baird's opinion (Mam. N. Am., 1857, p. 195) that while the "species varies considerably in its markings," "individuals from the same locality are usually quite similar," his opinion being apparently based on a series of five specimens from Middleboro', Mass. It is unnecessary to repeat or even summarize the statements already on record in regard to the variability of Skunks in Massachusetts. It may be of interest, however, to supplement this with a few facts respecting the variability of Skunks at other localities.

As is well known skunk skins are extensively employed by furriers, being sold under various euphemistic names, as 'fitch,'

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'American sable,' etc., and used in the manufacture of carriage robes, muffs and trimmings. Their market value depends largely upon their color, those with most white being least valuable, the price declining as the amount of white increases. Dealers usually separate the skins into four grades, the first being worth six or seven times as much as the fourth. The localities to which reference is here made are Vermont, Indiana and eastern New York.

I am indebted to Mr. Walter W. Granger, of this Museum, for important information about Skunks killed within a few miles of Rutland, Vt., which is to the following effect, the prices mentioned being those paid in 1893.

No. 1. Price, $1.40 per skin. Nearly all black, the only white being a small spot on the nape.

No. 2. Price, 90 cts. Nearly all black, but generally with small shoulder stripes in addition to the white nuchal patch.

No. 3. Price, 55 cts. With about the average amount of white, all of the usual white markings being fairly well developed.

No. 4. Price, 25 cts. Nearly the whole back white, forming a broad white mantle, with generally a narrow median line of black.

From a newspaper account entitled 'The Skunk-skin Harvest,' originally published in the Indianapolis, Ind., 'News,' in September, 1879, I take the following in relation to the skunk-skin trade in "central and southern Indiana," where one dealer is said to have "handled 20,000 skunk skins last year [1878], nearly all of which were caught in Indiana." The skins are classified in four grades, as follows:

"A No. 1, star skunk;" price, $1.75. All black except "a star-shaped white spot on the top of the head."

No. 2, the "short stripe;" price $1.25. This has a short white stripe running back from the nuchal patch on to the shoulder.

No. 3, the "narrow stripe;" price, 40 cts. This has a narrow white stripe on each side running back nearly to the tail.

No. 4; price, 20 cts. With a broad band of white on each side, three inches or more wide, and extending the whole length of the body.

I am indebted to Mr. William Wallace, also of this Museum, for the following information respecting 500 Skunks taken last year at Cobleskill, N. Y. (about fifty miles west of Albany), all killed within a radius of five miles:

No. 1, all black, except a white spot on the nape; price, $1.40; number of skins, 100.

No. 2, nearly all black; a short white stripe on the shoulders in addition to the white nuchal patch. Price, 80 cts; number of skins, 100.

No. 3, with the narrow white shoulder stripes extending a little further back. Price, 40 cts; number of skins, 120.

No. 4. The greater part of the back white, the lateral white stripes very broad and extending back nearly to the tail, separated generally by a narrow median band of black. Price, 20 cts.; number of skins, 180.

Mr. Wallace also informs me that an enterprising farmer in the Catskills has a successful 'skunk farm' in operation. For several years he has been raising Skunks for their oil and skins, and in order to improve the skins for the market, he is purchasing all the live Skunks, of either sex, of grade 1, he can obtain, in order to develop, if possible, a breed of black Skunks.

From the foregoing it is evident that the Skunks of at least Massachusetts, Vermont, eastern New York, and central and southern Indiana, are subject to a wide range of color variation, and it is probable that these localities are not exceptional in this respect. While data sufficiently numerous from other parts of the continent are mostly lacking, it may be of interest to mention the few at hand respecting the Skunks of Arizona.

Some years since a valued correspondent wrote to me of his experience with Skunks in Arizona. He says: "By the way, I do not believe in the wide range of individual variation usually accredited to the Skunks. In Arizona I had several unusual opportunities of examining all the young ones of a litter, and in each instance they were almost exactly alike. The Indians here skin (and eat!) a great many, and the variations are very slight indeed....[Here follows a description of the coloration, illustrated by diagrams, of the species Dr. Merriam had shortly before described as *Mephitis estor*.] In the Arizona skunk the only variable point is the amount of black in the middle line posteriorily, the white side stripes crowding it to a greater or less degree. In only one of several hundred specimens examined was the black entirely crowded out, the whole back and the whole upper side of the tail being white." A series of 8 specimens collected near Fort Verde, Arizona, so far as they go, bear out this statement. They agree perfectly with the original description of *Mephitis estor* Merriam (N. Am. Fauna, No. 3, Sept., 1890, p. 81).

On the other hand, a series of 15 specimens from a single locality in Pinal Co., Arizona, collected Nov. 13, 1886 to Jan. 23, 1887, by Mr. W. E. D. Scott, are as variable as can well be imagined, some being almost entirely without white markings, while in others the whole dorsal surface is nearly uniform white. Thus in No. 1357 the whole animal is black, except for a very narrow white frontal stripe, slight tufts of white hairs behind the ears, a narrow broken line of white on the right side, a few scattered white hairs on the left side, the extreme base of the tail hairs, and a long terminal pencil of white at the tip of the tail. In No. 1352 the whole back and the upper surface of the tail are white, except for a very narrow median line of black on the hinder part of the back. Between these two extremes there is a finely graduated series of intermediate stages. One (No. 1346) almost wholly lacks the frontal stripe, and has no trace of the nuchal patch, but there are narrow lateral white stripes, the one on the right side much heavier than the one on the left; the tail has a terminal white pencil, and the basal third of the hairs is white. Another (No. 1359) has a narrow frontal stripe, a very large nuchal patch, and a short narrow lateral white stripe on the left side, with the tail as in the last, except that the terminal pencil has nearly fallen out. Another (No. 1356) is like the last, except that the nuchal patch extends into a narrow white point to beyond the shoulders, and there is no white on the sides of the body. Another (No. 1350) has a well-developed frontal stripe, but the nuchal patch is nearly wanting; the lateral stripes are fairly well developed, but bifurcate anteriorly into two, one terminating just behind and below the ear, the other just above it. From this stage there is a gradual transition to those with a wholly, or almost wholly, white back.

Four specimens of the series have the posterior half of the white dorsal area grayish, through the admixture of many black hairs with the white ones. In four out of six of the blackest specimens the tail has a terminal pencil of very long white hairs (five to six inches in length), as in the eastern *M. mephitica*, and there is a trace of it in the other two. These are rather young (one-half to two-thirds grown) specimens. It seems therefore probable that in this species this long terminal pencil is a feature of youth, as it is absent in adult specimens. It is also possible that the Pinal County series is separable from the Fort Verde series, but satisfactory evidence of this is at present lacking. In the accompanying table of measurements, however, the two series were kept separate in computing the averages and ratios. The only difference seems to consist in the slightly smaller size of the Pinal County series, which also averages younger, so that this slight difference may be doubtless safely attributed to the average difference in age between the two series.

29. Spilogale indianola *Merriam.*

Spilogale indianola MERRIAM, N. Am. Fauna, No. 4, Oct. 1890, p. 10 ; ALLEN, Bull. Am. Mus. Nat. Hist. III, pp. 219, 308 (Tamaulipas, Mexico, and Corpus Christi, Texas).

This species is represented by five Texas specimens and one from Tamaulipas. Four of the Texas specimens are in Mr. Attwater's collection, and were taken in the immediate vicinity of Rockport. One is a very young example, which differs in color from the adults only in the white markings being pure white instead of more or less creamy white.

The series is very uniform in coloration, and leaves nothing to be added to the descriptions I have already given (l. c.) based on the Corpus Christi and Tamaulipas specimens.

Mr. Attwater refers to them as rare, and says he knows little of their habits. He has met with them only on the peninsulas, and does not know whether they are to be found on the islands.

30. **Putorius brasiliensis frenatus** (*Licht.*). BRIDLED WEASEL.—Unrepresented in the collection, but Mr. Attwater reports it as of occasional occurrence in Aransas County, and says one was recently taken near Rockport.

31. **Canis latrans** *Say.* COYOTE.—No specimens were sent, but Mr. Attwater furnishes the following interesting notes:

"Still common on the prairies inland, and often seen in parts of Aransas County. They are frequently seen from the car windows in passing on the railway in San Patricio County. They are disturbed in the early morning by passing trains from their feast on the dead carcasses of animals killed by being knocked off the track. They do not seem to mind the cars much, as they only slink off for about fifty yards and sit up waiting for the train to pass. In this position they become targets for the trainmen, who shoot at them with revolvers. Several persons have told me that while watching for turkeys they have observed Coyotes catching grasshoppers."—H. P. A.

32. **Urocyon virginianus** (*Schreber*). GRAY FOX.—Represented by a single imperfect skin, loaned by Mr. Attwater for examination.

"I have the skin of one of these little foxes, which was brought to me in 1892. It was killed on Live Oak Peninsula, about six miles from Rockport. These foxes are common inland. I think they subsist largely on the Texan Bobwhite (*Colinus virginianus texanus*), as do also the wild cats, throughout southwest Texas. I have frequently come across bunches of the feathers of the Bobwhite. These animals easily scent them out during the night. The Bobwhite has become quite scarce in Aransas County, of late years, and I attribute the rare occurrence of foxes and some other animals here to this cause."—H. P. A.

33. **Lynx rufus maculatus** (*Horsf. & Vig.*). WILD CAT.—Two specimens received from Mr. Attwater are provisionally referred as above. Mr. Attwater states that they are still found occasionally in Aransas County.

34. **Felis onca** *Linn.* JAGUAR.—Now extirpated. "Captain Bailey says he formerly owned a fine skin of a Jaguar killed on the point of Live Oak Peninsula by J. J. Wealder and A. Reeves, in 1858, but has not heard of any in this neighborhood since."—H. P. A.

35. **Felis concolor** *Linn.* PANTHER.—"Captain Bailey tells me the Panther was common here twenty-five years ago, and remembers riding right on to one, in the long prairie grass on Capano Bay, about 1857. It was in the act of devouring a deer which it had killed."—H. P. A.

36. **Felis pardalis** *Linn.* OCELOT; LEOPARD CAT.—"These used to be occasionally found in Aransas County. The last one was killed several years ago by Levi Phillips and William Tally a few miles from Rockport in the brush. I received this information from Capt. N. C. Phillips, a well-known farmer now living in Aransas County."—H. P. A.

Article VII.—FOSSIL MAMMALS OF THE LOWER MIOCENE WHITE RIVER BEDS. COLLECTION OF 1892.

By Henry Fairfield Osborn and J. L. Wortman.

With two Plates and eight figures in Text.

Introductory Note.

The reports from the Department of Mammalian Palæontology in the American Museum are published in two series. The *Faunal series* includes at present the *Wahsatch Fossil Mammals*, the *Cretaceous Fossil Mammals*, and the present *Lower Miocene Fossil Mammals*, Part I. This series is designed to cover the entire Museum collections from certain horizons, and not only to include descriptions of new forms, but to serve as a descriptive guide to the collection for the use of specialists. The *Special series* includes preliminary notices of important types which it is advisable to publish promptly. In the latter series four papers have already been devoted to the Lower Miocene Collection of 1892, namely: upon *Protoceras*;[1] upon *Artionyx*,[2] which Scott has now shown to be identical with *Agriochœrus* Leidy; upon the *Divisions of the Lower Miocene*;[3] upon *Aceratherium tridactylum*;[4] and upon *Ancestors of the Tapir*.[5]

The present is the first part of a report belonging to the 'faunal series,' and covers part of the fossils collected in 1892. More recent collections and the remainder of this will be treated in a second part. These collections were made by Dr. Wortman, assisted by Mr. Peterson and Mr. Gidley.

The most novel points in the present paper are:

1. New characters of the Lower Miocene Rhinoceroses, including two new types, *A. trigonodum* and *A. platycephalum*.
2. The osteology of *Metamynodon*.

[1] Osborn and Wortman, Bull. Am. Mus. Nat. Hist., Vol. IV, Dec. 30, 1892.
[2] Loc. cit., Vol. V, Osborn and Wortman, February, 1893.
[3] Loc. cit., Wortman, June 27, 1893.
[4] Loc. cit., Osborn, April 29, 1893.
[5] Loc. cit., Wortman and Earle, August 18, 1893.

Succession of Species in the White River Miocene.

Approximate estimate of the thickness of the Beds.	General Character of Rock.	Types appearing for Last Time, Italicized.
100 feet.	Leptauchenia Layer: nodule-bearing, pink-colored clays.	Pogonodon sp.? Eporeodon major, Leptauchenia sp., Aceratherium tridactylum, *Hyracodon*, Hyænodon?
Protoceras Beds. 50–75 feet.	Coarse sandstones, not continuous.	Hyracodon sp., Aceratherium tridactylum, Aceratherium platycephalum, Diceratherium proavitum, Protapirus obliquidens, *Mesohippus bairdii*, Mesohippus sp., Elotherium imperator, Thinohyus sp., Anthracotherium karense, Hyopotamus brachyrhynchus, Protoceras celer, Agriochœrus gaudryi, Pogonodon sp. (?)
Barren Clays. 100 feet.	Light-colored clays.	A few scattered mammalian remains.
75 to 100 feet.	Nodulous clay stratum. Bones white.	Oreodon bullatus, Hyænodon crucians, H. cruentus, Daphænus, Palæolagus haydeni, Ischyromys typus, Leptictis haydeni, *Metamynodon*, Leptomeryx evansi, Hyracodon, Pöebrotherium wilsonii, *Aceratherium occidentale*, Dinictis felina, Hoplophoneus primævus.
	Sandstones and clays. Bones rusty colored.	Aceratherium occidentale, Mesohippus bairdii, Hyracodon sp., Elotherium imperator, E. mortoni.
Oreodon Beds. 10 to 20 feet.	Oreodon Layer: nodule-bearing. Bones with scale of ferruginous oxide. 'Red layer.'	Hyracodon sp., Aceratherium mite, Aceratherium occidentale, Mesohippus bairdii, Colodon luxatus, Protapirus simplex, Elotherium mortoni, Elotherium imperator, Anthracotherium occidentale, Hyopotamus americanus, Pöebrotherium wilsonii, Leptomeryx evansi, *Oreodon culbertsonii*, *Oreodon gracile*, Hoplophoneus primævus, Hoplophoneus occidentalis, Hyænodon horridus, Hyænodon paucidens, Hyænodon crucians, Hyænodon cruentus, Daphænus, Ischyromys sp., Palæolagus haydeni.
50 feet.	Metamynodon Layer: sandstones and clays. Bones rusty. Reddish gritty clay. Bones white.	Hyracodon sp., *Aceratherium mite*, Metamynodon planiceps, Oreodon culbertsonii, Mesohippus bairdii, Hoplophoneus primævus, Elotherium mortoni, Elotherium imperator.
Titanotherium Beds. (Total thickness, 180 feet.)	Mingled remains of Titanotherium, Aceratherium, Mesohippus.	*Aceratherium trigonodum*, Mesohippus bairdii, Anthracotherium occidentale, Elotherium mortoni (?), Oreodon culbertsonii (?), *Titanotherium*.

3. The basi-occipital characters of *Oreodon* as developed in successive horizons.
4. The determination of two species of *Anthracotherium*. Additional characters of the American *Hyopotamus*.

The section upon the Perissodactyla was mainly written by myself; that upon the Artiodactyla and Carnivora by Dr. Wortman. Authors, in citing this paper, are requested to kindly recognize the names of both contributors.—H. F. O.

FAUNAL SUCCESSION IN THE LOWER MIOCENE.

One of the most important features of the field work of the Expedition of 1892 was a very careful survey of the complete section of the Lower Miocene beds in South Dakota. Wortman has already published a preliminary table of the succession of strata,[1] and we now add a preliminary list of the succession of species. This will naturally be subject to revision; some species will be found to occur upon higher or lower levels, and the list characteristic of each level will be greatly increased. In the meantime the following list will furnish the basis for definite criticism and revision, and taken together with the admirable work of Scott upon the Deep River beds, and of Hatcher upon the lower section or Titanotherium beds, is a step towards the still more exact stratigraphical and faunal work of the future.

Suborder PERISSODACTYLA.

Family RHINOCEROTIDÆ.

Aceratherium trigonodum, sp. nov.

PLATE II, *A*.

This species is the oldest of the series, and is named from the strictly triangular form of the last upper premolar. The best specimen is a nearly perfect skull (No. 529) with one jaw found

[1] 'On the Divisions of the White River or Lower Miocene of Dakota,' Bull. Am. Mus. Nat. Hist., V, pp. 95-106, June 27, 1893.

in the uppermost 'Titanotherium layer.' The type specimen (No. 528) is a perfect set of upper grinders of both sides, only partly worn.

The specific characters are : Dentition, $\frac{1}{1}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$. (*a*) *Upper canine* apparently persistent and well developed. (*b*) *Upper premolars* subtriangular ; third premolar with an incipient postero-internal cusp, well developed towards the base ; fourth premolar with a feeble or incipient postero-internal spur and a somewhat prominent elevation of the postero-internal cingulum, which presents the appearance of a 'cingule' when worn. (*c*) *Upper molars* with well-developed internal cingulum upon protoloph ; cingulum feeble or absent on metaloph ; incipient 'antecrochet' at base of metaloph becoming apparent upon wear. (*d*) *Skull* (No. 529) fairly elevated ; sagittal crest low ; nasals rather short, not notched ; postglenoid and posttympanic processes widely separated.

The canine associated with specimen No. 529 was not found *in situ*, and is therefore open to some question ; it is larger than

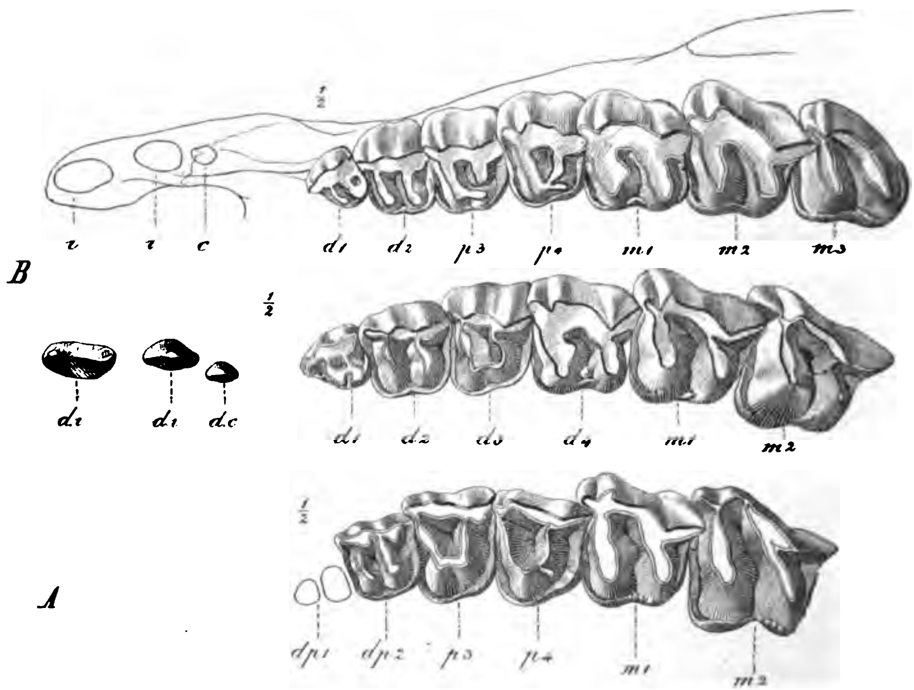

Fig. 1. Upper dentition of the left side of : A, *Aceratherium trigonodum*, type (No. 528). B, *Aceratherium mite*, showing immature dentition (No. 521). *Aceratherium mite*, showing mature dentition (No. 522). One-half natural size.

that of *A. mite.* The lower jaw is long and slender ; it lacks any trace of the first premolar ; the lower canines differ from those of *A. occidentale* in being fully procumbent. The nasals are relatively shorter and more obtuse than in *A. mite ;* the sagittal crest is less sharply defined. The postglenoid processes extend more widely behind the glenoid fossa than in the later types.

Aceratherium (Cœnopus) mite *Cope.*

PLATE II, *B.*

This species has been hitherto known chiefly in its teeth and skeletal characters, from the descriptions of Cope. It is represented by three beautifully preserved skulls, one containing the complete milk dentition (No. 521), the others containing the adult dentition in two stages of wear (Nos. 522, 524). Found at the base of the 'Oreodon Beds' (Nos. 521, 522), and in the 'Metamynodon layer' (No. 524).

The specific distinctions of the skull region are : Dentition, ^{2}, $^{1-0}$, ^{4}, ^{3}. (*a*) Small *upper canines* present in milk series, and temporary or absent in permanent dentition. (*b*) *Upper premolars :* third premolar subtriangular with a small but well-defined postero-internal cusp (tetartocone), and a short posterior crest ; fourth premolar subtriangular with a somewhat feebler tetartocone. (*c*) *Upper molars* with more or less well-defined internal cingula, especially upon the protoloph, 'antecrochet' usually distinct upon first molar and feeble or absent upon second and third molars ; third molar with ectoloph and metaloph completely confluent. (*d*) *Skull* rather broad and low ; sagittal crest well-defined posteriorly ; occiput of medium height ; frontals broad and somewhat rugose above postorbital processes; nasals notched laterally and sharply pointed; postglenoid and posttympanic processes separate.

These skulls are small and delicate, about 17 inches in length. The general impression one receives is of considerable lateral and moderate vertical extension. The premaxillaries are not overhung by the nasals, and are completely separated in the median line. Seen from above, the nasals, pointed at the tip, widen suddenly as in *Hyrachyus*, with which generic type *A. mite* presents many striking resemblances. The skull gradually broadens to a point above and slightly behind the orbits, then contracts into the rather broad, low cranium. The premaxillaries are almost in contact with the nasals.

The younger individual (No. 521) shows all the upper premolars of the *first series* in place. The first premolar has a long ectoloph and two irregular transverse crests. The second premolar has two perfect transverse crests. The third premolar has two crests which are confluent internally; it is more triangular in form and less progressive than the second premolar. The fourth premolar is on the other hand more progressive than the molars,

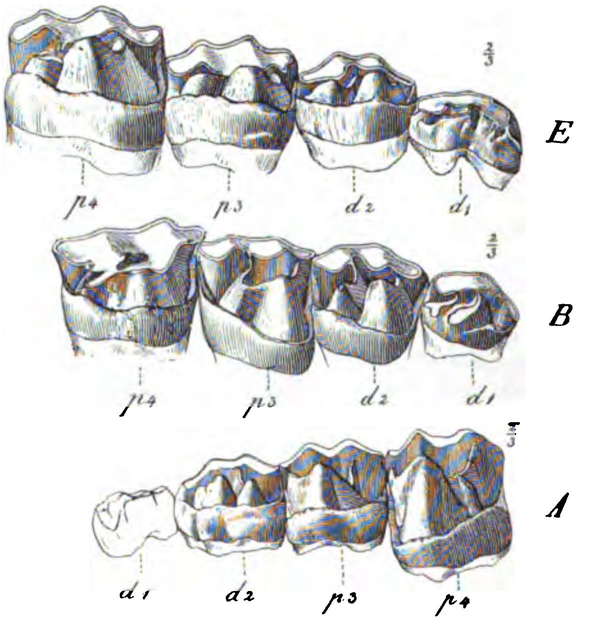

Fig. 2. Adult Upper Premolars of the First and Second Series A, *Aceratherium trigonodum*, type (No. 528). B, *Aceratherium mite* (No. 522). E, *Aceratherium platycephalum* (No. 540). Showing by the internal view the persistence and unchanged form of the two 'milk' teeth, D. 1 and D 2, and the evolution of the postero-internal lobe in the third and fourth premolars, P. 3, P. 4. Two-thirds natural size.

with protoloph and metaloph, an antecrochet and a tubercle at the entrance of the median valley. It is somewhat doubtful whether the incisors and the canine belong to the first or second series.

Aceratherium occidentale (*Leidy*).

PLATE II, *C*.

This classic species is represented by numerous specimens, including three fairly well-preserved adult skulls (Nos. 532, 535, 537), and one perfect baby skull and jaws (No. 534). It seems to occur chiefly above the 'Metamynodon layer' in the middle and upper divisions of the 'Oreodon Beds.'

The specific distinctions are: Dentition, $\frac{2}{2}$, $\frac{0}{1}$, $\frac{4}{4-3}$, $\frac{3}{3}$. (*a*) *Upper canines* wanting in deciduous and permanent series; lower canines with crowns of medium length, semiprocumbent. (*b*) *Upper premolars:* third premolar subquadrate, with strong tetartocone and posterior crest not quite in contact in the unworn condition; fourth premolar transitional to subquadrate with feebler development of tetartocone and posterior crest. (*c*) *Upper molars:* internal cingula fairly well defined, especially upon protolph; 'antecrochet' well developed upon first and second molars, and sometimes present upon third molar; third molar with ectoloph and metaloph completely confluent. (*d*) *Skull* rather high and narrow; nasals long, well developed and slightly notched; sagittal crest flattening out except in posterior region of cranium; postglenoid and posttympanic processes approximated but not actually in contact; occiput elevated; paroccipital processes very long and slender.

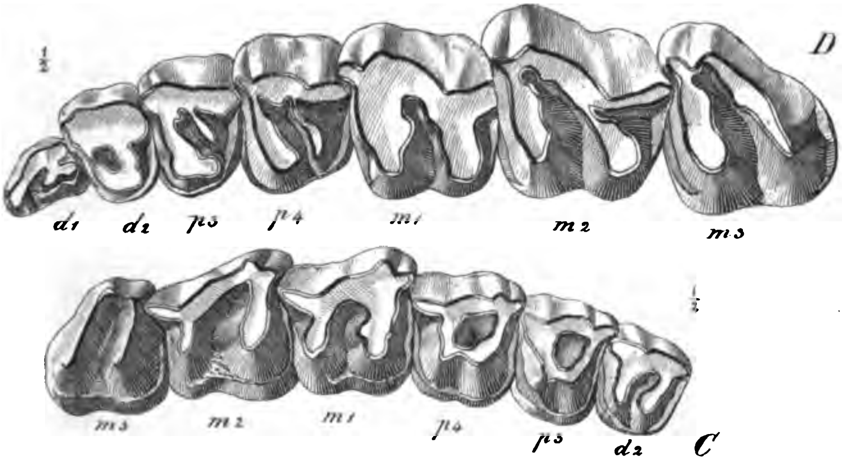

Fig. 3. Adult Upper Dentition of C, *Aceratherium occidentale* (Leidy) (No. 535), and of D, *Aceratherium platycephalum*, type (No. 545). One-half natural size.

The immature skull (No. 534) is doubtfully referred to this species. In contrast with the young *A. mite* it exhibits a feeble pair of upper incisors, and no trace of the upper canines. The four deciduous premolars are the only grinding teeth present; they are all completely molariform, with two complete crests, except D. P. 1, which exhibits a strong postero-internal cusp and a very feeble posterior crest. There is a 'crista' upon D. P. 2.

Aceratherium platycephalum, sp. nov.

Plate II, *E*.

The type of this species is a skull and lower jaw (No. 545) from the coarse sandstones or lower section of the 'Protoceras Beds,' on the same level with *A. tridactylum*. Belonging to the same species is a perfect set of upper premolars and molars of the right side (No. 540).

The specific distinctions are as follows: Dentition, $\frac{1}{2}, \frac{0}{0}, \frac{4}{4-3}, \frac{3}{3}$. (*a*) Third and fourth *upper premolars* with prominent postero-internal cusps (tetartocones) which when unworn are quite separate from the delicate posterior crests; third premolar quadrate; fourth premolar subquadrate. (*b*) Internal cingula upon true *upper molars* wanting; first molar exhibits an 'antecrochet'; third molar exhibits a depression on the posterior face at the junction of the ectoloph and metaloph. (*c*) Large procumbent lower canines, with a small median pair of incisors. (*d*) *Skull* flattened, obtuse nasals, slight postglenoid-posttympanic contact; broad, low occiput; sagittal crest wanting and represented merely by two low, divergent *linea aspera* about one inch apart.

Both specimens (Nos. 545, 540) belong to a large animal. The skull is about 25 inches in length, and is wholly different in its proportions from that of the contemporary *A. tridactylum*, which is of the high narrow type, and about 20 inches in length. The prominent bosses above the post-orbital processes, the short obtuse nasals, the very large horizontal lower incisors, or canines, the flattened upper surface of the cranium, are all characters which immediately distinguish this type. The proportions of the skull suggest that this species may have succeeded the *A. mite* Cope.

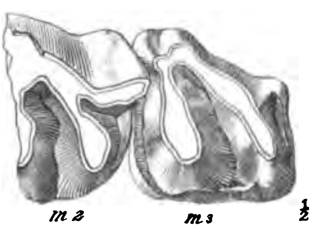

Fig. 4. Second and third upper molars of *Aceratherium simplicidens* Cope, type. One-half natural size.

The last upper molar is somewhat similar in form to that of *A. simplicidens* Cope.

Aceratherium tridactylum *Osborn*.[1]

Plate II, *E*, and Plate III.

This species was founded upon the remarkably complete skeleton represented in Plate III. Other remains are a fine skull

[1] Bull. Am. Mus. Nat. Hist., Vol. V, April 29, 1893, p. 85.

(No. 541), and many fragmentary portions of the skeleton. Found in the coarse sandstones or lower division of the 'Protoceras Beds.'

The specific distinctions are : Dentition, $\frac{2}{1}$, $\frac{0}{1}$, $\frac{4}{4}$, $\frac{3}{3}$. (*a*) The *upper premolars* cannot be clearly defined at present, owing to the adult wear. (*b*) Internal cingula upon *upper molars* faintly developed or wanting ; first, second and third molars with strong 'antecrochet.' (*c*) Semiprocumbent lower canines. (*d*) *Skull* elevated, elongate nasals, broad postglenoid-posttympanic contact, high occiput, powerful sagittal crest.

The following paragraph is from the original description of the type specimen :[1] "The skeleton measures seven feet nine inches in length, and four feet in height to the top of the lumbar vertebral spines. There are nineteen dorsal, five lumbar and three sacral vertebræ. The pelvis is long and rather slender, and the limbs are of an intermediate type, heavier than in *A. occidentale* and much longer than in the Upper Miocene *A. fossiger*. There are only three digits in the manus, hence the name *tridactylum*, there being no trace of the fifth digit, which is so characteristic of the Lower Miocene Rhinoceroses of America and Europe, with the possible exception of *A. mite* Cope."

In the type the nasals are perfectly smooth, but in another skull (No. 541) the nasals exhibit a pair of rugosities which at once suggest the possession of a pair of horns, and Mr. Hatcher[2] has recently shown that this species is followed by another, related to the John Day genus *Diceratherium* Marsh. The distinctive features of the skull are the high, narrow occiput, and powerful sagittal crest, the arching and rugose nasals overhanging the premaxillaries, the posterior lateral projections of the zygomatic arches, the widely united postglenoid and posttympanic processes. The dentition is characterized by the medum sized semiprocumbent lower canines, and by the strong 'antecrochet' upon the upper molars.

General Features of the Lower Miocene Rhinoceroses.

Plates II and III.

From these observations it appears that there was a very rapid evolution both in form and in size among the Lower Miocene

[1] Loc. cit.
[2] American Geologist, May, 1894, p. 360.

Rhinoceroses, also that there was considerable variety and a number of parallel lines of species. The succession in *time* is: *A. trigonodum*, *A. mite*, *A. occidentale*, *A. tridactylum*, and *A. platycephalum*. The relative appearance in time of *A. simplicidens* Cope and *A. pumilum* Cope has not been ascertained, nor do we understand as yet the phyletic succession of any of these species.

The transformation of the upper premolars is particularly interesting: first, in the retention of the D. P. 1 and D. P. 2 as permanent teeth, the latter exhibiting fully molariform transverse crests; second, in the more rapid evolution of the third premolar than of the fourth premolar. Quite the reverse of this is the case in the horses, where the fourth premolar is more progressive than the third.

The discovery of *A. tridactylum* and of *A. platycephalum* was quite unexpected. The former may connect with *Diceratherium* through the *D. proavitum* of Hatcher. The latter is an altogether unique form, as it resembles none of the later Miocene types thus far discovered. The distinctive features of the skull evolution are well shown in Plate II.

Family AMYNODONTIDÆ *S. & O.*

In this family of aberrant Rhinoceroses are included the genera *Amynodon*, *Metamynodon*, and possibly *Cadurcotherium*, a European form which presents many analogies to the American Amynodonts. The previous family definition given by Osborn may now be amended as follows:

Large upper and lower canines. Upper and lower incisors reduced in number, and of a uniformly small size. Premolar series in both jaws greatly reduced. Last upper molar with a complete ectoloph. Skull with a short facial region and powerful sagittal crest. Functional digits 4–3. Lunar wedge-shaped distally.

We are now enabled to fully compare these animals with the Rhinocerotidæ, the most striking differences being in the peculiar form of the skull, the great canine tusks, and the four functional toes in front. Very numerous minor differences run throughout the dentition and skeleton, and indicate ancient divergence from the Rhinoceros stem.

Restoration.—The most complete individual, which we refer to *M. planifrons*, gives us all the proportions of the body. The adult was about 9½ feet long and 4½ feet high at the shoulders, with a low, compactly built body, muscular limbs and deep chest. The vertebral spines were not elevated. Thus the general appearance of the animal, with its low, broad skull, widely spreading zygomatic arches and tusks, was widely different from the contemporary *Aceratherium* with its light build, feeble canine tusks and high, narrow skull.

Metamynodon planifrons *S. & O.*

All the specimens in the collection (Nos. 546–554) are provisionally referred to this species. The variations in size and dental formulæ do not afford the basis for specific separation from the type at present.

The material collected in 1892 embraces remains of nine individuals, as follows: *A*, from *Metamynodon stratum:* No. 546, greater part of skeleton, fragments of skull, lower jaw complete, lacking pelvis and lumbars; No. 547, skull; No. 549, lower jaw; No. 550, lower jaw of young individual, with milk teeth; No. 551, jaws of young individual; No. 552, fragmentary lower jaw; No. 553, complete lower jaw. *B*, from *Upper Oreodon stratum:* No. 548, fore limb; No. 696, lower jaw.

Skull and Lower Jaws.

The osteology of the skull has already been fully described; the lower jaws are long and not very deep; the condyle is elevated, with great transverse and slight antero-posterior section. The coronoid is slender; the border of the angle is thickened as in *Rhinoceros*. The symphysis is long and horizontal with a single mental foramen.

Dentition.—The dental formula as given by Scott and Osborn requires modification, as there is evidence that the number of incisors is less than stated by them. In skull No. 555 there are three upper incisors upon one side and two upon the other. Of the lower jaws, Nos. 551 and 546 present two incisors upon each side, while No. 555 has but a single incisor upon each side. There are three upper premolars and two lower premolars as a number constant in all the specimens. The dental formula should therefore be written I. $\frac{3-2}{2-1}$, C. $\frac{1}{1}$, Pm. $\frac{3}{2}$, M. $\frac{3}{3}$. The *incisors* are subfunctional, being better developed than appeared in the Harvard College type skull. The most exceptional feature is the large *canine* tusks, which are 3½ inches in length in the lower jaw, and 2 inches in length in the upper jaw. The lower canines are strongly recurved, trihedral in section, with posterior faces worn flat by close friction with the anterior faces of the upper canines. Both pairs of tusks diverge, and are outwardly curved like those of the wild boar. The *premolars* are characterized by extreme reduction in size, the antero-posterior diameter of the entire premolar series being less than that of the second true molar. They also show a limited assumption of the molar pattern, as has been already pointed out. The *upper molars* are distinguished by the flattened external face of the ectoloph, which in M. 3 is carried well beyond the metaloph, a feature which is very rare in the true Rhinoceroses. There is a trace of the 'crista' in M. 2 in one specimen (No. 547.) There is no internal cingulum, and the transverse crests are devoid of either the crochet or antecrochet.

The *lower molars* are remarkable for their extremely high, elongate and laterally compressed crowns, which exhibit a tendency to a prismatic or hypsodont structure. The anterior crest is strongly and sharply incurved. In the molars of Nos. 550, 555, 546 a prominent tubercle appears at the entrance of the posterior valley. The third molar has only two lobes, as in the true Rhinoceroses.

THE SKELETON.

Vertebræ.—The following description refers exclusively to No. 546, unless otherwise specified. The atlas indicates powerful transverse processes; the suboccipital foramen perforates the anterior part of the arch. The axis is rather elongate, and exhibits an obtuse odontoid process. The remaining cervicals have strongly opisthocœlous centra, with oval faces, the greatest diameter being transverse; the zygapophyses are large and slightly oblique; the neural spines are not preserved; the seventh cervical is imperforate, and its centrum shows a facet for the first rib. Fifteen *dorsals* are preserved. The first dorsal has a broad descending lamella from the transverse process with a facet for the tuberculum of the first rib; the capitulum of the first rib articulates at the anterior base of the process. The succeeding dorsals lack the lamella; the adjacent facets for the capitulum of the rib become confluent between the third and fourth dorsals; the capitulum is supported on adjacent facets between each pair of vertebræ as far back as the 15th dorsal. The tubercular facet is also exhibited upon the 15th dorsal, the last one completely preserved. The zygapophyses are very small, and are horizontal in position from the first to the 11th dorsal, when they begin to take an oblique position; in the 15th they are considerably rounded and obliquely placed. The dorsal spines are not very elevated in the mid-dorsal region, and they sink rapidly towards the posterior end of the series; they have a trihedral section; they are keeled anteriorly, and deeply excavated posteriorly from D. 3 to D. 12, where the upper portion of the spine assumes the broad flattened form characteristic of the lumbars. No vertebræ are preserved behind the 15th dorsal except five of the caudals.

Ribs.—Fourteen ribs of the right and six of the left side are preserved, indicating that there was a deep, rather narrow chest. The first rib has an oval section above and is flattened below. The 2d to the 7th ribs have flattened shafts; the ribs from the 8th to the 14th pass from a trihedral to a rounded section. From the length of the ribs it is estimated that the depth of the chest was about 35 inches.

Scapula.—Of the scapula only the lower portion is preserved. It exhibits a shallow glenoid fossa, a low rugose corocoid process.

Humerus.—The humerus is massive, with prominent greater and lesser tuberosities, a rugose deltoid crest slightly retroverted, but not hooked, extending half-way down the shaft. The ectepicondyle is very prominent, and there is a supratrochlear foramen. The internal condyle is perfectly flat. The relative measurements of the humerus and the radius are 16 in. to 13 in.

Radius.—The radius has a characteristic pit on its front face just above the insertion of the *brachialis anticus;* the shaft is flattened, and distally presents a very strongly concavo-convex face for the scaphoid, and slightly concave face for the lunar.

Ulna.—The ulna has a short olecranon, a trihedral shaft and a prominent rugosity on the median external face ; distally there is a deep groove upon the anterior face for the passage of the extensor tendon ; it rests partly upon the lunar as well as upon the cuneiform.

The *pelvis* is wanting.

Hind Limbs.—The hind limbs are characterized by the great length of the femur in proportion to the tibia—the ratio being femur, 19 inches ; tibia, 11 inches. The head of the *femur* has a large pit for the *ligamentum teres*, a prominent rugose great trochanter which does not rise above the head ; a shallow digital fossa ; the lesser and third trochanters are low and placed well down upon the shaft; the rotular groove faces obliquely downwards, indicating that the knee was carried well up ; the external and internal tuberosities are equal ; the external condyle is the largest. The *tibia* has a double spine, a broad cnemial crest, which exhibits a deep median superior depression ; the internal malleolus is not prominent, and the astragalar trochlear, as in *Aphelops*, is shallow. The *fibula* is complete although reduced, with an expanded distal extremity ; the shaft is trihedral in section and not laterally compressed.

Manus.—The manus exhibits the articulations and relations invariably associated with tetradactylism, viz. : the lunar is wedge-shaped distally, and is supported equally upon the magnum and unciform instead of mainly upon the unciform, as in the Rhinoceros and in tridactyl types generally. The bones of the proximal row are in other respects similar to those in *Rhinoceros*. The distal row shows a small trapezium ; the second digit being supported by the trapezoid and abutting against the magnum ; the third and fourth digits articulate with the magnum and unciform in the usual manner, and the fifth is well developed, as indicated by a broad horizontal unciform facet. The larger specimen (No. 548) from the "upper Oreodon stratum" exhibits a third digit and a large fifth digit fully as functional as in *Titanotherium*, and more strongly developed than in the Tapir.

Pes.—The pes is remarkable especially for the form of the tuber calcis, which is elongate, flattened, expanded distally, and has its long axis placed nearly transversely instead of antero-posteriorly. The cuboid has a larger astragalar than calcaneal facet, while the astragalus itself is very short. The middle metapodial abuts against the cuboid. As a whole the pes is very short.

In addition to the points above noted, *Metamynodon* is distinguished from the modern Rhinoceros by a lesser development of the humeral tuberosity and of the third femoral trochanter, by the elongated neck for the head of the femur, and by the shortness of the astragalus. Upon the whole, however, it is much more advanced and specialized in the direction of the modern Rhinoceros type than the contemporary *Aceratherium occidentale.*

Family EQUIDÆ.

Subfamily ANCHITHERIINÆ.

CHARACTERS OF THE LOWER MIOCENE SPECIES OF HORSES.

The typical form, *Mesohippus bairdii*, extends apparently unmodified in form and very slightly increasing in size from the lowest to the highest beds, while just above the Oreodon strata a distinct and much larger form appears, and in the highest strata (Protoceras Beds) a second larger type appears transitional to the John Day *Anchitherium.* We thus observe the *persistence of primitive species of Horses contemporary with divergent progressive species* as a characteristic of the evolution of the Horses. This is in accord with the previous observations of Marsh, confirmed by Scott and Osborn, that a form *? Anchitherium parvulus*, which is very slightly removed in dental characters from *Mesohippus*, occurs even in the top of the Miocene (Loup Fork);[1] also with Scott's recent observations upon the polyphyletic series of the upper Miocene (Deep River) Horses of North America.

Mesohippus bairdii (*Leidy*).

This well-known species is represented by remains of sixteen individuals—Nos. 664–677, 712, 713—chiefly from the 'Oreodon'

[1] See Scott and Osborn, Bull. Mus. Comp. Zoöl., 1890, p. 89.

and 'Metamynodon' strata, including all parts of the skeleton and of the dentition excepting the incisor teeth. Among the most valuable specimens for morphological study is the nearly complete skeleton of a young individual, No. 685.

INCERTÆ SEDIS.

? Mesohippus longipes, sp. nov.

The type of this species is a complete hind limb (No. 684), found just above the 'nodular layer' in the sandstones and clays of the upper 'Oreodon beds.'

It presents certain points of likeness with the hind limb of *Hyracodon nebrascense*, as well as with that of the *Miohippus annectens*, recently described by Scott from the 'Deep River Beds' of Montana, which lie at the base of the Loup Fork or Upper Miocene.[1] In other words, if really a Horse it is a much larger and more modernized type than the *M. bairdii*. The animal stood about 31 inches high at the hip, while *M. bairdii* stood 21 inches high.

The pelvis is similar to that of *M. bairdii*, so far as we can determine from the small portion preserved. The femur has a deep pit for the *ligamentum teres*; the great trochanter is missing; the third trochanter is placed higher upon the shaft than the second. The tibia has a greatly elevated cnemial crest. The fibula is reduced to a continuous extremely slender shaft closely applied to the side of the tibia. The calcaneum has a long tuber calcis, and displays a small fibular facet; the ectal superior calcaneo-astragalar facet is separate, while the ental and inferior facets are continuous, thus differing widely from the separate facets of *M. bairdii*, and resembling those of *H. nebrascense*. On the other hand the astragalo-tibial grooves of the ankle joint are much sharper than in any known species of *Hyracodon* and resemble those of the Horses. The cuboid articulates with the astragalus by a very narrow facet as in both the Horses and Hyracodons. The navicular displays a deep postero-external facet for the cuboid. The ectocuneiform is very deep with an

[1] 'The Mammalia of the Deep River Beds,' Trans. Am. Phil. Soc., Vol. XVII, May, 1894, p. 80.

external facet for metatarsal IV. The mesocuneiform is short. The entocuneiform has a small navicular facet.

The toes spread distally; the lateral pair are relatively larger and more oval in section than in *M. bairdii*. The proximal phalanges are much longer relatively than in the typical Horses. Altogether it is very doubtful where this animal belongs. It is widely distinct from both the known lower Miocene Horses and Hyracodons.

The specific characters are: (*a*) Metatarsals 3, long and slender, slightly spreading distally. (*b*) Sustentacular and inferior calcaneo-astragalar facets continuous. (*c*) Astragalo-tibial grooves sharp. (*d*) Fibula complete, but greatly reduced and closely applied to tibia.

Suborder ARTIODACTYLA.

Family OREODONTIDÆ.

An unusually fine series of skulls of the Oreodonts from all levels of the White River formation enables us to add something to the knowledge of the vertical distribution of the species. It has been stated at various times that remains of Oreodonts occur in the lower Titanotherium Beds, but careful search in the region explored by our party, viz.: the divide between the White and Cheyenne Rivers, has failed to bring to light a single specimen of the group from these underlying strata. All the specimens in our collection were found in the Oreodon and Protoceras Beds, or middle and upper divisions.

Oreodon culbertsonii *Leidy*.

Remains of this species are exceedingly abundant in the lower 'nodular layer' of the 'Oreodon Beds'; it is from their relative abundance in this stratum that this primary division of the White River sediments takes its name. The typical nodular layer, in which their remains are especially numerous, lies within fifteen or twenty feet of the top of the Titanotherium strata, and it is not an unfrequent occurrence to find them also in the clays immediately overlying the Titanotherium Beds; in fact it is highly probable that the species has been found in the extreme uppermost layers of the Titanotherium Bed proper.

So far as our collection shows, the vertical range of *O. culbertsonii* does not exceed thirty feet, extending from the top of the Titanotherium Beds, upwards some distance above the lower nodular or 'red layer.' It is probable, however, that more extensive collections will increase this limit considerably both above and below.

The principal characters of this species are seen in the very small, uninflated tympanic bullæ, the form of the paroccipital processes, and the presence of a distinct and separate foramen rotundum. In the absence of any accurate description of this region of the skull, it is here treated in some detail for purposes of comparison with later types. The specimen described and figured is No. 595. The bullæ are small and rugged in contradistinction to the large, smooth, rounded form found in the later species. The paroccipital processes are rather elongated, more or less triangular in section, especially at the base, and connected with the posterior portion of the bullæ by prominent ridges. At the base of the paroccipital process, on the side looking towards the postglenoid, are seen two fossæ, separated from each other by a well-marked lamina of bone extending out from the paroccipital; in the anterior of these fossæ is found the point of articulation of the tympanohyal element of the hyoid arch, while in the posterior fossa is seen the external opening of the stylomastoid foramen.

At the posterior termination of the pterygoid plate of the sphenoid, and immediately in advance of the bulla, is situated the *foramen ovale*, while upon the outer side of the root of the pterygoid, in advance of, and a little internal to the foramen ovale, is seen another distinct, though smaller, foramen, which is in all probability the *foramen rotundum*. In front of this again come the large sphenoidal fissure and the optic foramen.

Oreodon gracilis *Leidy*.

This species, of which there are a number of skulls in our collection, has practically the same vertical distribution as *O. culbertsonii*. It is readily distinguished by its smaller size, by the

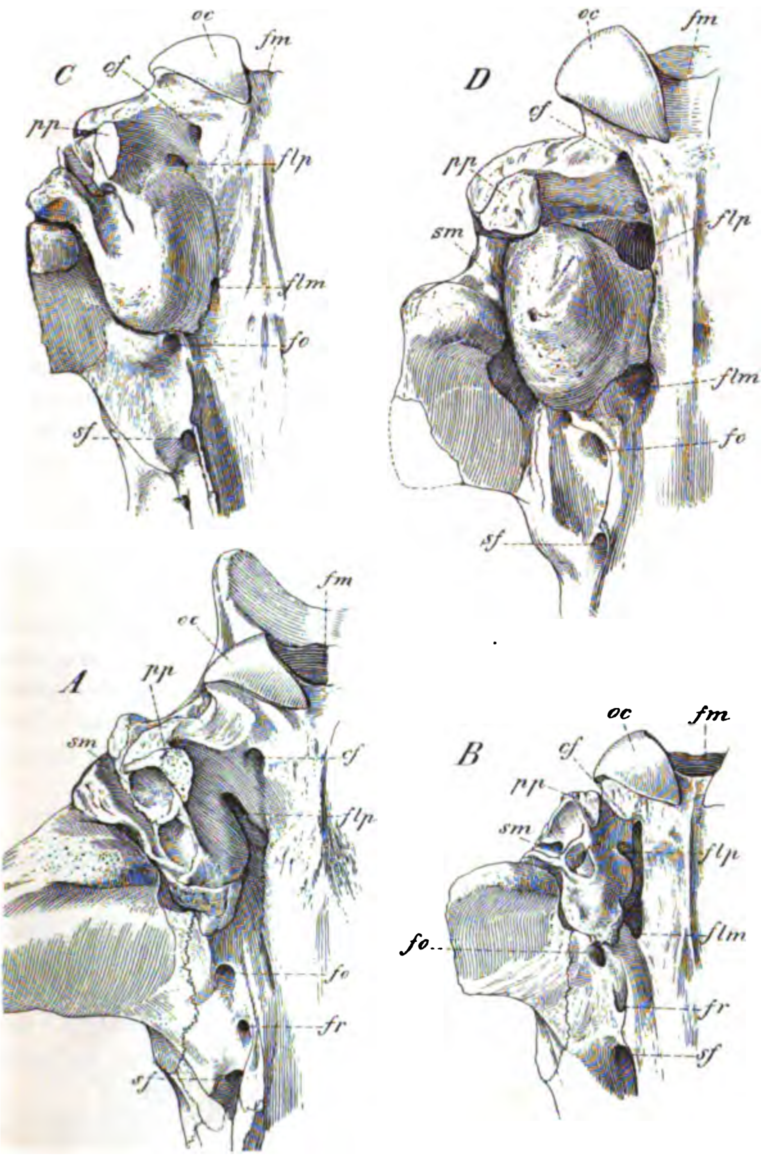

Fig. 5. Evolution of the Basi-occipital Region in Oreodon. C, *Oreodon bullatus* (No. 611). D. *Eporeodon major* (No. 1038). A. *Oreodon culbertsonii* (No. 595). B, *Oreodon gracilis* (No. 596). Natural size.

somewhat greater inflation of the bullæ, and by the less distinct double fossa at the base of the paroccipital. It has, however, a distinct and relatively large foramen rotundum. Fig. 5 *B* (No. 596).

Oreodon bullatus *Leidy.*

There is a single skull of this species in our collection (No. 611) which was obtained from the second 'nodular layer,' from seventy-five to a hundred feet above the 'red layer' of the 'Oreodon Bed.' It is a matter of much interest to note that the bullæ are much more inflated than in either *O. culbertsonii* or *O. gracilis.* They are, moreover, extended backwards and are largely in contact with the paroccipitals, which are, however, not flattened from before backwards to any appreciable extent. The posterior fossa at the base of the paroccipital is but faintly represented, the anterior being large and distinct.

The *foramen rotundum* is represented by two very minute vestigial foraminæ at the sides of the pterygoid plate, between the sphenoidal fissure and the 'foramen ovale.' It is more than probable that these will be found wanting in many specimens of this species. In our specimen they certainly could not have been functional, and there can be little doubt that the superior maxillary nerve made its exit through the sphenoidal fissure. The foramen rotundum therefore may be said to be practically absent.

Eporeodon major (*Leidy*).

In the overlying Protoceras Beds Oreodons are very numerous. They are found principally in a nodular layer just as in the lower beds. So far as our collection shows, all the species of this upper horizon exhibit greatly inflated bullæ (see No. 1038); the paroccipital is flattened at its base and applied closely to the bullæ; there is no posterior fossa at the base of the paroccipital, and the foramen rotundum is entirely wanting. The crowns of the teeth are more elongated, and the species are slightly larger.

It is stated by Scott[1] upon the authority of Marsh,[2] that in the Oreodons from the John Day horizon the thumb is absent and

[1] Morpholog. Jahrbuch, Vol. XVI, p. 339.
[2] 'Notice of New Tertiary Mammals,' Amer. Jour. Sci., Vol. IX, p. 239–250.

that the bullæ are inflated. This character of the absence of the thumb is regarded by Scott as sufficient ground for the separation of these species into a distinct genus (*Eporeodon*). He does not apparently regard the species with the inflated bullæ from the White River formation as belonging to this genus, and criticises Marsh for proposing the genus upon the ground of the inflation of the bullæ. He remarks further that the forms with the large bullæ occur together with those of the uninflated bullæ in the same strata. This is not borne out by our observations. As regards the presence or absence of the thumb in the species from the Protoceras Beds very little is known at present, but it is a fact, abundantly demonstrated by our collection, that the greatly inflated bulla type, with flattened paroccipitals and lacking the foramen rotundum, comes *only from the upper or Protoceras Beds.* In a like manner those species in which the bullæ are little or not at all inflated, the paroccipitals are not flattened and the foramen rotundum is present, are confined to the lower part of the Oreodon Beds. The single example of the transitional form, *O. bullatus*, has a position exactly intermediate, in respect to its vertical distribution. These facts are significant, and seem to demonstrate very conclusively that the range in time corresponds with the evolution of the bullæ.

Family ANTHRACOTHERIIDÆ.

The expedition was fortunate in securing a number of specimens of *Hyopotamus*, including several more or less complete skulls and lower jaws, and of still greater interest the first remains of *Anthracotherium* found in this country, proving that the Anthracotheriidæ were represented by both the characteristic European genera.

Hyopotamus americanus *Leidy.*

This species, which has hitherto been known only from isolated teeth, is represented by the anterior portion of the skull (No. 575) and other remains. The molar teeth agree precisely with Leidy's type, and enable us to characterize this species more fully. It is of precisely the same size as the *H. velaunus* from Ronzon, as figured by Filhol. It also resembles this European species closely in the greater elongated, narrow muzzle, but differs from it in the absence of the first superior premolar. The skull, so far as preserved, does not present any further differences.

The locality is the 'Metamynodon stratum,' in which the remains of several individuals were found. Among them is a series of three upper molars (No. 576) which are of considerably larger size; also some lower jaws with milk teeth.

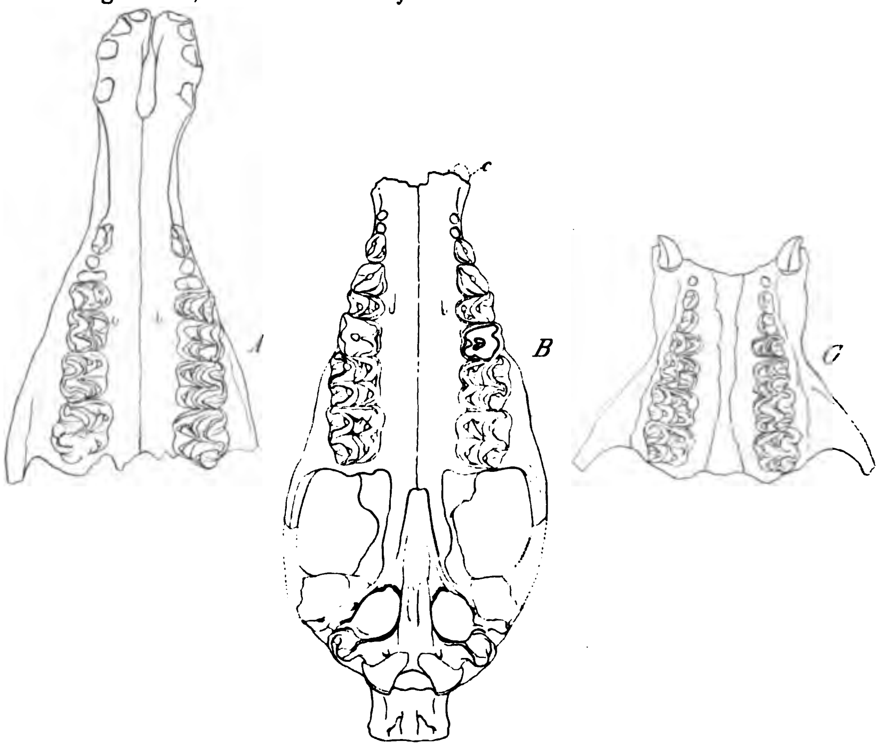

Fig. 6. Palatal Views of Skulls of Anthracotheres. A, *Hyopotamus americanus* Leidy (No. 575). B, *Hyopotamus brachyrhynchus*, type (No. 582). C, *Anthracotherium curtum*. One-fourth natural size.

Hyopotamus brachyrhynchus, sp. nov.

The type of this species is a skull (No. 582) from the overlying Protoceras Beds; it is well distinguished by the shortness of the muzzle, as the specific name indicates. The interval between the base of the canine and the second premolar is but one-half as great as in *H. americanus.* There is also a well-developed bifanged first premolar.

METAMYNODON BEDS.

H. americanus.

I.^{3}, C.^{1}, P.^{3}, M.^{3}. Muzzle elongated, C. to P.^{2} = 70 mm. Second upper premolar with feeble internal cingulum.

PROTOCERAS BEDS.

H. brachyrhynchus.

I.$^{-}$, C.^{1}, P.^{4}, M.^{3}. Muzzle short, C. to P.^{2} = 36 mm. Second upper premolar with strong internal cingulum. Molar cingula and styles strongly developed.

The type skull of *H. brachyrhynchus* is shorter than that referred to *H. americanus*, but otherwise is of the same proportions. The principal characters are as follows : Orbits open posteriorly ; a sagittal crest ; occiput compressed laterally, as in *H. aymardi ;* paroccipital process prominent and separated from the postglenoid by the tubular portion of the tympanic. The tympanic bullæ are well inflated as in the Peccary, but are lower, more rounded, and more elongated antero-posteriorly.

Fig. 7. Superior Dentition of *Anthracotherium ? curtum* Marsh. Two-thirds natural size.

Anthracotherium curtum *Marsh.*

The specimen referred to this species is part of a skull (No. 1039) containing the canine, and the complete premolar-molar series of the left side, and the fourth premolar and three molars of the right side. In size it resembles the smaller European species. There is absolutely no diastema.

Upper dentition.—The canine is vertically placed and more triangular in form than in the European species, and exhibits a sharply worn anterior face. Pm. 1 is missing ; it is single-fanged. Pm. 2 has traces of the cingulum at the outer angles and upon the inner face. In Pm. 3 these features are strengthened, and this tooth exhibits a postero-internal shelf. Pm. 4 has a well-developed internal cusp (deuterocone) surrounded by a basal cingulum ; the protocone is subcrescentic. The molars exhibit rather low obtuse cusps of crescentic form, with the characteristic protoconule ; the parastyle and mesostyle are low and obtuse ; the metastyle is rudimentary or incipient except in M. 3 ; the internal cingulum is not very prominent. In general these teeth are of the low selenodont type found in the European forms.

The locality is the 'Metamynodon stratum' of the Oreodon Beds. The description of this specimen was completed when a communication was published by Professor Marsh[1] of a new species, *Heptacodon curtus*, founded upon a single molar tooth, and said to be "apparently allied to *Hyopotamus*." The type of *H. curtus* is slightly smaller than the specimen here described. The author does not recognize the relationship to *Anthracotherium*.

Anthracotherium karense, sp. nov.

This is a larger form from the Protoceras Beds, and is represented by the last two upper molars of the left side (No. 1040). It is well distinguished by the very strong development of the

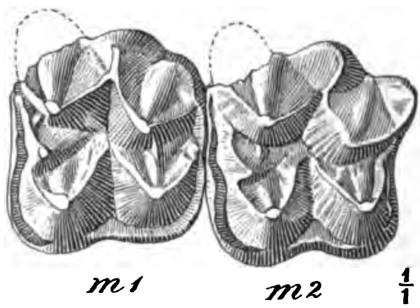

Fig. 8. First and Second Upper Molars of *Anthracotherium karense*, type. Natural size.

mesostyle upon M. 2 and M. 3, and by the prominent metastyle upon M. 3. The molars are of larger size than in *A. occidentale*, the cusps are more elevated and more sharply crescentic, the in-

[1] 'A New Miocene Mammal,' Am. Jour. Sc., May, 1894, p. 409.

ternal cingulum is also much more prominent. In general these teeth approach more nearly the *Hyopotamus* type, excepting of course in the form of the mesostyle.

This species is named after one of the prominent peaks in the Black Hills—*Inyan Kara.*

METAMYNODON BEDS.	PROTOCERAS BEDS.
A. occidentale.	*A. karense.*
C.^{1}, P.^{4}, M.^{3}. Molars with low cusps semibunodont. Feeble metastyle on M.3. Internal cingulum not prominent. *Measurements:* M.2-3, 40 mm. Width M.3, 23 mm.	Formula unknown. Cusps of molars elevated and crescentic. Mesostyle a prominent crested spur. Metastyle very prominent in M.3. *Measurements:* M.2-3, 54 mm. Width, M. 3, 27 mm.

Order CREODONTA.

Family HYÆNODONTIDÆ.

Hyænodon paucidens, sp. nov.

This species is based upon an unusually perfect skull and lower jaw. The most striking characters in which it differs from all other Hyænodons hitherto discovered, is the absence of the first premolar in the upper jaw. The dental formula therefore is I. $\frac{3}{3}$ C.$\frac{1}{1}$, Pm.$\frac{3}{4}$, M.$\frac{2}{3}$, instead of I.$\frac{3}{3}$, C.$\frac{1}{1}$, Pm.$\frac{4}{4}$, M.$\frac{2}{3}$, as it is in all other species of this genus so far known. It has generally been the practice among palæontologists to regard a character of this importance as of generic value, and there are doubtless few who would hesitate to propose a new genus for its reception, but the skull in every other respect is so very like that of the other species of *Hyænodon* that it is deemed inadvisable to pursue such a course.

Careful examination shows that the absence of this tooth is not an accidental variation. In the first place the space which the first premolar should occupy is relatively shorter than in the nearest ally, *H. crucians*, being only 10 mm., whereas in *H. crucians* it is 15 mm. The entire length of the tooth line measuring from the posterior border of the upper canine to the posterior border of the last molar is 80 mm. in *H. crucians*, and 70 mm. in *H. paucidens*. The third premolars in both the upper and lower jaws have a more oblique position, and the teeth are more crowded than in *H. crucians*. The skull is slightly smaller, the muzzle narrower and the canines longer and more robust than in *H. crucians*. The palatal region agrees very closely with that of *H. crucians* in having the palatines in contact throughout their entire length, and the pterygoid plates of the alisphenoid separate in the median line. In this respect both species differ markedly from the species described by Scott,[1] *H. leptocephalus*, in which the pterygoid plates are in contact for a long distance. The interorbital constriction in the skull of *H. paucidens* is placed at the fronto-parietal suture, where the two diverging branches of the sagittal crest meet, as in the larger species *H. horridus* and *H. cruentus*. In *H. crucians* both are situated in advance of the interorbital constriction.

A synopsis of the American species of the genus may now be given as follows :[2]

I. *Superior Premolars 4.*
- *A*. Posterior nares opening between posterior part of palatines ; pterygoid plates of alisphenoid not in contact below.
  - *a*. Cranial constriction in advance of fronto-parietal suture.......................................*H. crucians.*
  - *b*. Cranial constriction at fronto-parietal suture.
    - *aa*. Face very deep ; an external buttress on anterior lobe of last lower molar....*H. horridus.*
    - *bb*. Face shallower ; buttress absent.......*H. cruentus.*

II. *Superior Premolars 3*.....................................*H. paucidens.*
- *B*. Palatines in contact throughout ; pterygoid plates of alisphenoids meeting below................*H. leptocephalus.*

Hyænodon crucians *Leidy*.

A tolerably well-preserved skull of this species is represented in the collection, together with some few fragments of the skeleton. The skull is already well known, and does not call for any further mention. A fragment of the atlas shows that the transverse processes are pierced by the vertebral canal quite in the ordinary way. Two lumbar vertebræ exhibit the usual characters

[1] Journal Acad. Nat. Sci. Philad., Ser. 2, Vol. IX, No. 2.
[2] See Scott, Journal Acad. Nat. Sci., Vol. IX, p. 175.

of the Creodonts in the complex mode of articulation of their zygapophyses. Their centra are strongly keeled below, and there are small though distinct anapophyses present. A fragment of the pelvis, including a part of the acetabulum and the ilium, is interesting as showing the relatively prominent tubercle for the origin of the *rectus femoris*, as well as the absence of the pubic spine. The ilium is apparently little expanded, and there is a distinct cotyloid notch. The proximal end of the femur shows a well rounded globular head, placed upon a constricted and rather elongated neck ; the head is marked by a distinct pit for the *ligamentum teres*. The digital fossa is of moderate size, and there is a small though distinct third trochanter. Only the shaft of the tibia is preserved, which indicates a moderately stout bone with considerable lateral compression and a prominent cnemial crest, as in the dog. A fragment of the shaft of the fibula shows that it was much reduced in size, and was slender and delicate. The calcaneum has a moderately elongated tuber ; a large facet for the fibula, a prominent external tubercle, and a very oblique facet for the cuboid.

The Milk Dentition of Hyænodon.

A rather complete lower jaw of a young Hyænodon, pertaining to a small species (presumably *H. crucians*) contained in the collection, renders it possible to give a description of the milk dentition of the inferior series. Filhol has described[1] the inferior milk dentition of *Hyænodon cayluxi*, and considered the important fact of their supposed relationship with the Marsupials. Our specimen is more complete than Filhol's, and includes the canines and incisors in addition to the molars and premolars. The roots of two incisors upon the left side are preserved in position, which, together with an alveolus for the third tooth, enables me to state that there were three incisors upon each side. Just as in the permanent dentition, the second or median incisor is crowded back out of position ; their crowns are missing. The canines are small, much curved and sharp pointed, very much as they are in the dog. The root is compressed later-

[1] 'Mammifères Fossiles des Phosphorites,' Paris, 1877.

ally, the enamel is extended down much lower upon the outside than upon the inside of the tooth, and there is a faint indication of a cingulum well up towards the point upon the inside.

As regards the milk molars, our specimen shows that the first tooth situated behind the canine did not develop a successor, and, as in the dog and so many other diphyodonts, is a *persistent milk tooth.* The second deciduous molar is missing, having already been shed ; a fragment of a root on the left side, however, indicates that it had been present. The third milk molar is still retained in position, and would have been, judging from the advanced state of eruption of the permanent tooth immediately beneath, the next one to be discarded. Its general form is like that of the corresponding permanent tooth destined to succeed it, with some few trifling exceptions ; it is, however, notably smaller and weaker in every way. The crown is made up of a principal cusp, to which is added in front a very weak and indistinct basal cusp, together with a somewhat stronger cusp and cingulum behind. The fourth deciduous molar is slightly larger than the preceding one. Its structure is very similar to the first permanent molar, which lies immediately behind it, with which it also agrees very well in size. The crown consists of three cusps, the two anterior of which form a rather imperfect though distinct pair of sectorial beads; the third cusp is basal and makes up the weak heel or talon. Its structure is more complex than that of its permanent successor, as is so universally the case among the Carnivora.

It is proper to speak in this connection of the peculiar character of the first lower true molar of the Hyænodonts in general, since our specimen seems to throw some light upon this question. If the adult, permanent dentition of any of either the European or American species of *Hyænodon* be examined, *the small weak first lower molar* is a very noticeable and constant feature. The great disparity in size between it and the tooth immediately in advance, as well as the one immediately behind it, is very marked. It is, moreover, always much more worn, lighter in color, and has all the characteristic marks of a persistent milk tooth. I am now able to state from the condition of wear that *it was protruded early with the milk set*, and not after the lapse of a considerable period, as is always the case among other diphyodonts. If therefore we are to judge of it by its size, date of appearance, as well as its general structure, it will be necessary to classify it with the first series in the time of its eruption.'[1] If this be true it points to a condition among the ancestors of the Creodonts wherein there were five instead of four teeth protruded together.

This peculiarity of the first lower molar is not confined to *Hyænodon*, but is also seen in *Pterodon* and many species of *Stypolophus* as well, although perhaps not so distinctly. It is perhaps another fact suggesting the lineal descent of *Hyænodon* from *Stypolophus*.

Order CARNIVORA.

Family NIMRAVIDÆ.

Genus **Hoplophoneus** *Cope.*

This type is represented by two species, the smaller of which, *H. primævus*, is the most abundantly represented. Both species appear to be confined to the 'Oreodon Beds.' Although fragmentary feline remains were also found in the upper 'Protoceras Beds,' they cannot be identified with certainty, and it is probable that they do not pertain to the *Hoplophoneus* type, insamuch as they indicate an animal of much larger proportions.

Hoplophoneus occidentalis *Leidy.*

This species is represented in the collection by two individuals, in one of which the skull and nearly all the vertebræ are preserved, and in the other the limbs and vertebræ in excellent condition, thus rendering it possible to give a complete restoration of the animal.

The chief distinction between the two known White River species is found in the superior premolar formula. In *H. primævus* there are three premolars above, whereas in *H. occidentalis* there are only two. There is another very constant and important

[1] See Wortman, 'American System of Dentistry,' p. 500.

difference between the two species in the matter of size. A comparative statement of the measurements of some of the more important bones brings this fact out very clearly.

	H. occidentalis.	*H. primævus.*
Length of Humerus	200 mm.	170 mm.
" Ulna	212	163
" Radius	160	132
" Femur	250	195
" Tibia	188	160
" Sacrum	100	73

In the numerous specimens of both species in our collection, the astragalus shows a remarkably flat trochlea, as in the Creodonts, and the astragalar foramen is present and well developed. In the carpus the scaphoid, lunar and centrale are united, but the suture between the two first-mentioned bones is always visible even in old individuals.

Article VIII.—ON THE AFFINITIES OF LEPTARCTUS PRIMUS OF LEIDY.

By J. L. Wortman.

Up to the present time but very little has been known of the existence of the peculiarly American family Procyonidæ in any deposits older than the very latest Quartenary. Leidy has described and figured[1] an isolated last upper tooth, from the Loup Fork deposits of Nebraska, under the name of *Leptarctus primus*, which has been referred to this family. The Museum Expedition of last year into this region was successful in obtaining additional material, which we provisionally refer to Leidy's species.

Leptarctus primus *Leidy*.

The specimen consists of the right ramus of the lower jaw, carrying the third and fourth premolars and the canine. The condyle is broken away, but the coronoid process and the angle are preserved. The specimen is from a young individual in which the last premolar had just cut the gum. The alveoli of all the other teeth are present and in a good state of preservation.

The dental formula is as follows: I. $_3$, C. $_1$, Pm. $_3$, M. $_2$. The incisors are not preserved, but their alveoli indicate that they were much crowded, the outside one being placed almost directly in front of the canine, and the middle one pushed back considerably out of position. This series is in marked contrast with that of the Raccoon, in which the crowns of the incisors form almost a straight line across the jaw, and the middle one is crowded backwards to a very slight extent. The canine is peculiar and differs markedly from that of the Raccoon. It is rather robust, very much recurved and grooved by a deep vertical sulcus upon its antero-internal face. This sulcus is but faintly indicated in the Raccoon. The postero-external face of the crown is marked by a sharp ridge which becomes more prominent near

[1] Extinct Fauna of Dakota.

the apex. The first premolar is not preserved, but its alveolus indicates that it was a single-rooted tooth, placed behind the canine after the intervention of a very short diastema. The second premolar is bifanged; its crown is composed of a principal cusp, to which is added behind a small though very distinct second cusp. There is in addition to these cusps a distinct basal cingulum, most prominent in the region of the heel. The third premolar, like the second, is double rooted; its crown moreover is made up of two cusps, the posterior being almost as large as the principal one. These cusps do not stand in the line of the long axis of the jaw, but are placed very obliquely to it. The heel is not very prominent, but the basal cingulum is well developed, both in front and behind. As compared with the Raccoon, the second premolar is more complex in that it has two cusps instead of one. In the third premolar the posterior cusp is much better developed, and placed more obliquely than in the corresponding tooth of *Procyon*; the heel is moreover not so broad.

The first molar is not preserved, but judging from the size of its roots it was decidedly the longest tooth of the series. The second molar was likewise bifanged but much smaller; it was placed close against the base of the coronoid.

The whole jaw has, relatively, a greater depth than that of the Raccoon, and is remarkably straight upon its lower border, whereas in the recent genus it is considerably curved. The condyle is not preserved, and the angle is somewhat damaged, but it was apparently not so strongly inflected as in the Raccoon. The masseteric fossa is deep and prominent, and the coronoid is high and broad. The inferior dental canal is placed higher than it is in the Raccoon, being slightly above the tooth line. The symphysis is relatively deeper and more robust than in *Procyon*, and the chin is heavier and more abruptly rounded.

The jaw of *Leptarctus* differs from that of *Cercoleptes* in the following characters: the coronoid is broader and of less vertical extent; the condyle is not placed so high; the angle is elevated above the lower border of the ramus, which is straight and not concave as it is in *Cercoleptes*. In the depth of the symphysis and abrupt rounding of the chin the two genera are similar. *Cercoleptes*, moreover, has a moderately deep groove upon the antero-internal face of the canine, but differs from that of *Leptarctus* in having an external groove as well. *Cercoleptes* again resembles *Leptarctus* in having only three premolars in the lower jaw ; the middle one, however, has only a single cusp upon the crown, whereas *Leptarctus* has two.

As compared with *Bassaricyon*,[1] the jaw is more robust, shorter and deeper, with a more prominent chin. The two genera differ again in the number of premolars.

Altogether, *Leptarctus* appears to offer a number of transitional characters between the more typical Procyonidæ and the aberrant *Cercoleptes*. This is especially to be seen in the proportions of the jaw, the reduction of the number of premolars, the reduction in size of the last molar, as well as the depth of the mandibular symphysis.

[1] See J. A. Allen's paper, Proc. Phil. Acad., 1876, p. 21.

Article IX.—CRANIAL VARIATIONS IN NEOTOMA MICROPUS DUE TO GROWTH AND INDIVIDUAL DIFFERENTIATION.

By J. A. ALLEN.

PLATE IV.

In view of the stress naturally, and very properly, laid upon the importance of cranial characters in the discrimination of species in groups of closely-allied forms, it seems desirable to ascertain the character and amount of change in not only the general form of the skull but in the form of its separate bones due to growth, and also to determine the amount and kind of individual variation that may be expected to occur in skulls unquestionably of the same species. Having of late had occasion to examine a large amount of material relating to the genus *Neotoma*, the subject has been forcibly brought to my attention, and some of the results of a careful examination of a large series of skulls pertaining to several species of this genus are here presented. No attempt is made to treat the subject exhaustively, only a few special points being here presented.

As is well known to all experienced workers in mammalogy, the general contour of the brain-case, the relative size and form of individual bones, notably the interparietal, and the condition of the supraorbital and other ridges for muscular attachment, alter materially after the animal reaches sexual maturity; the deposition of osseus matter, the closing of sutures, the building out of crests and rugosities continuing throughout life, so that a skull of a very old animal may differ notably from that of an individual of the same species in middle life, and this latter from one just reaching sexual maturity.

The Museum has at present a large series of specimens of *Neotoma micropus* Baird, including ages ranging from nursling young to very old adults. They are mainly from three localities in the eastern coast district of Texas, namely, Brownsville, Corpus Christi, and Rockport. In order to avoid any complications that might arise through geographic variation, only the specimens from Rockport and Corpus Christi—localities less than twenty-five miles apart, and similar in physical conditions—are here considered. There is not the slightest reason for questioning their conspecific relationship. The series selected to illustrate variations due to age are, with one exception, from Rockport; those figured to show individual variation are all from Corpus Christi.

Variations due to Age.

General Contour.—The variation in the general form of the skull resulting from growth is due mainly to the lengthening of the several skull segments without a corresponding relative increase in the breadth of the skull. Hence in the young skull, in comparison with an adult skull of the same species, the brain-case is disproportionately large in comparison with the anteorbital and basal portions of the skull. This is well shown in Plate IV, and in the subjoined table of measurements of three

Measurements and Ratios showing Cranial Variations due to Age in *Neotoma micropus.*

	No. 5834, ♀ juv.	Ratio[1]	No. 4480, ♂ juv.	Ratio[1]	No. 4478, ♂ very old.	Ratio[1]
Occipito-nasal length	31	100	41	100	53	100
Length of nasals	10	32.3	14.5	35.4	22	41.5
Length of frontais	13	42	15	36.6	18	34
Length of parietals on median line.	5	19.4	6	14.6	8	15
Greatest length of parietals	12	39	15	36.6	16	30.2
Length of interparietal	4.5	14.5	5.5	13.4	7	13.2
Length of brain-case	14	45.2	17	41.5	21	39.6
Greatest rostral breadth	5.5	17.7	6.3	15.4	6.5	12.3
Least interorbital breadth	6	19.4	6	14.6	6	11.3
Breadth of brain-case	16	51.6	19.5	45	20	38
Breadth of interparietal	11	35.5	10	24.4	7.5	14.2
Greatest zygomatic breadth	20?	64.6	23	56.1	30	56.6
Depth of skull at middle of palate	8	26	11	26.8	15	28.5
Depth of skull at front of basisphenoid.	11	35.5	12	29.3	14	26.4
Length of tooth-row (crown surface)	8[2]	25.8	8	19.5	9	17
Length of incisive foramina	6	19.3	8.5	20.7	11.5	21.7
Width of incisive foramina	3	9.7	3	7.3	3.5	6.6
Length of palatal floor	5	16.1	7	17	7	13.2

[1] Ratio to occipito-nasal length.
[2] From No. 4482, ♀ juv., in which the last molar has just come into use.

specimens of *N. micropus* from Rockport, Texas. No. 5834, ♀ juv., is a nursling so young that the last molar is still wholly enclosed in the jaw;[1] No. 4480, ♂ juv., though not quite full-grown, would pass as a 'young adult'; No. 4478, ♂ ad., is a very old male, with the teeth well worn down, and the fangs visible at the alveolar border. Other specimens in the series furnish a complete series of gradations between the two extremes (Nos. 5834 and 4478).

In general contour (Figs. 1–11, Pl. IV), the young skull, in comparison with adults, is much more convex in dorsal outline,[2] very broad posteriorly, and very narrow anteriorly. In comparing the relative length of the several skull segments the occipito-nasal length is taken as the basis, and the skulls will be referred to as *A* (=No. 5834), *B* (=No. 4480), and *C* (=No. 4478).

Rostral Segment.—In *A* the ratio of the rostral segment to the total length is 32.3 per cent.; in *B*, 35.4; in *C*, 41.5—giving a rapid *increase* in the ratio with age.

Frontal Segment.—In *A* the ratio of the frontal segment—*i. e.*, the distance between the naso-frontal and fronto-parietal sutures —to the total length is 42 per cent.; in *B*, 36.6; in *C*, 34—a considerable *decrease* in the ratio with age.

Parietal Segment.—In *A* the ratio of the parietal segment—*i. e.*, the distance from the latero-anterior angle of the parietal bone on either side to the occipito-parietal suture—to the total length is 39 per cent.; in *B*, 36.6; in *C*, 30.2—again a rapid decrease in the ratio.

Brain-case.—The length of the brain-case in *A* is 51.6 per cent. of the total length of the skull; in *B*, 45; in *C*, 38.

In each case the change in ratio is due to the disproportionate growth of the rostral portion of the skull. Thus in *A* the nasals have a length of only 10 mm.; in *B* they have increased to 14.5 mm., and in *C* to 22 mm., while the total occipito-nasal length of

[1] The length of the tooth-row given in the table is taken from an older specimen (No. 4482, ♀ juv.), in which the last molar has reached the level of the others and is just beginning to show traces of wear.

[2] In Figs. 10 and 11 it should be noted that the greater flatness of the skull interorbitally, as compared with Fig. 6, is masked by the raised supraorbital borders in the older skulls when viewed in profile.

the skull has increased only from 31 mm. in *A* to 53 mm. in *C*. In other words, the nasal bones have increased in length 120 per cent., while the total length has increased only 77 per cent.

Transverse Breadth.—In respect to the breadth of the skull the variations with growth are much less than in its length. Thus the greatest diameter of the rostrum varies only from 5.5 mm. in *A* to 6.5 in *C*—an increase of about 20 per cent. in the breadth of the rostrum, against an increase of 120 per cent. in its length. The interorbital breadth remains nearly constant, being 6 mm. in all three of the skulls here compared. The width of the brain-case shows an increase of 25 per cent. against an increase in the total length of the skull of 77 per cent. The zygomatic breadth shows an increase of about 50 per cent., due almost wholly to the thickening and increased convexity of the zygomatic arches.

Vertical Depth.—In respect to the depth of the skull, the variations with age prove especially interesting, although only such as would be expected from the facts already given. For present purposes the depth of the skull is taken at two points, namely, (*a*) at the middle of the palatal region, and (*b*) at the posterior border of the basisphenoid (basisphenoid-basioccipital suture). The palatal depth increases markedly with age, correlatively with the growth of the rostrum; the basisphenoidal depth changes but slightly after the molars have attained to functional development. Thus in *A* the basisphenoidal depth is 11 mm.; in *B*, 12 mm.; in *C*, 14 mm.—an increase of about 28 per cent. The palatal depth in *A* is 8 mm.; in *B*, 11 mm.; in *C*, 15 mm.—an increase of nearly 88 per cent.

Tooth-row.—The length of the upper tooth-row varies about 12 per cent., due almost wholly to the wearing down of the teeth, the length of the crown surface being much less, in slightly worn teeth, than the length taken at the alveolar border.

Interparietal.—The interparietal shows surprising modification with age, both as to size and form, but especially in respect to the latter. At early stages, as in *A*, this bone is more or less crescentic in shape, with the transverse diameter more than twice the antero-posterior diameter. Thus in *A* the two diameters are respectively 11 and 4.5 mm.; in *B*, 10 and 5.5 mm.; in *C*, 7.5 and 7 mm. In other words, the short, broad, convex sub-crescentic interparietal in *A* becomes transformed in *C* into a squarish, flat bone in which the two diameters are nearly equal, instead of the transverse being twice as great as the antero-posterior, as in *A*. This would be almost incredible were not the proof so abundantly furnished by the material in hand, where every stage of transition is shown. (Figs. 1–8, Pl. IV.) This change is coincident with the development of the raised supra-orbital borders and their prolongation backward as ridges to the parieto-occipital suture, and the flattening of the whole dorsal aspect of the post-rostral portion of the skull. In old age these ridges become confluent with the lateral edges of the interparietal which has now lost its postero-lateral moieties, partly apparently by absorption and partly by their being overgrown by the mediad posterior angle of the parietals. A sharp thin ridge for muscular attachment also extends back from the posterior base of the zygomatic arch. The interparietal at the same time develops a more or less prominent median angular projection at its posterior border, confluent with the median ridge of the supraoccipital. The contrast between these conditions, obtaining only in very old skulls, and their almost entire absence in skulls which have just reached sexual maturity, is strikingly great.

Supraoccipital.—The supraoccipital changes from a posteriorly convex, thin lamina of bone, in early life, to a thick, nearly vertical plate, with a strongly-developed median ridge produced into an angular spine at its superior border, and with a lateral ridge on either side about midway between the median line and its lateral borders; these lateral ridges also each develop an angular rugosity or process about midway their length. The superior border is also produced into an incipient occipital crest.

Basioccipital.—The basioccipital becomes greatly altered by growth, as in fact is the case with the whole postpalatal region. In comparing stages *A* and *C* it is found that the distance across the occipital condyles increases only about 15 per cent., while the breadth of the anterior border increases 100 per cent., and the length about 50 per cent. (Figs. 12-14, Pl. IV.)

Basisphenoid.—The basisphenoid doubles in length, and its anterior third becomes differentiated into a narrow projecting neck. The presphenoid at stage *A* is nearly hidden by the palatal floor. (Figs. 12-14, Pl. IV.)

Postpalatal Region as a whole.—This doubles its length with an increase in breadth of only about 50 per cent. At stage *A* the postpalatal border terminates slightly behind the posterior edge of M.2 ; in stage 3 it holds very nearly the same position. The distance between the postpalatal border and the front border of the auditory bullæ, compared with the total length of the skull, is as 1 to 9 in *A*, and as 1 to 5 in *C*. In *A* the pterygoid hamuli reach the second fourth of the bullæ ; in *C* they terminate slightly in advance of the bullæ. The bullæ themselves in *A* are more obliquely placed than in *C*, in relation to the axis of the skull, and are quite differently shaped. Also the form of the foramen magnum has undergone much change. These points are all well shown in Figs. 12-14 of the accompanying plate.

Incisive Foramina.—Consequent upon the growth of the rostral portion of the skull, the incisive foramina undergo marked change in form, and somewhat in position, as regards both their anterior and posterior borders. In the stage designated as *A* they are short and broad, and extend relatively further both anteriorly and posteriorly than in stage *B* or *C*, their anterior border being nearer the base of the incisors, and their posterior border being carried back to or slightly behind the front border of the first molar. Thus in *A* the length of the incisive foramina is 6 mm., with a maximum breadth of 3 mm., while in *C* the dimensions are respectively 11.5 and 3.5 mm.—a great increase in length with only slight increase in breadth. At the same time the anterior border is considerably further from the base of the incisors, and the posterior border is slightly in advance, instead of slightly behind, the front border of the molars.

Spheno-palatine Vacuities.—In adults of *Neotoma micropus*, as in other species of the 'round-tailed' section of the genus, there is a long, broad vacuity on each side of the presphenoid and anterior third of the basisphenoid, which Dr. Merriam has recently named[1] the '*spheno-palatine vacuities*,' and he has also called attention to the fact that they are not present in some forms of the 'bushy-tailed' section of the genus. It is therefore of interest in the present connection to note that these vacuities are absent at stage *A*, and are only partially developed at later stages (Figs. 12-14, Pl. IV). My attention was called to the matter by finding several nearly fully-grown skulls from Texas and northeastern Mexico with these vacuities either quite absent or represented by an exceedingly narrow slit, while I could find no differences in the skins or in other cranial characters that gave the slightest hint that the animals were not referable to *N. micropus*. Further examination of young skulls of undoubted *N. micropus* from Rockport and Corpus Christi, Texas, showed that the closed condition was in this species a feature of juvenility. It is thus of interest to find that a feature which proves to be merely a character of immaturity (and quite inconstant as well) in *N. micropus* is a permanent condition in *N. cinerea occidentalis*.[2]

In the development of these vacuities it appears that as the presphenoid increases in length it becomes reduced in width; at the same time, as the skull broadens, the edges of the ascending wings of the palatine bones become slightly incised. There is, however, much individual variation in this respect, as will be shown later.

Molars.—When the molars first cut the gum they have nearly the entire crown-surface capped with enamel. Very soon, even before the tooth has attained its full height, the enamel begins to disappear from the centers of the enamel loops, the capping remaining longer over the narrower loops than over the broader ones; it quickly disappears from all as soon as the crown-surface becomes subject to wear. In stage *A*, in which only M.1 and M.2 have appeared, and are less than one-third grown, the enamel walls of the loops nearly meet over the dentinal areas—quite meeting over the narrower portions, especially in the case of the middle transverse loop of each tooth. Some time before the age represented by *B* is reached, the crown-surface is worn to an

[1] Proc. Biol. Soc. Wash., VIII, p. 112, July, 1893.

[2] Unfortunately the outline figures here given (Figs. 12–15, Pl. IV,) fail to show clearly the points at issue.

even plane; the tooth has reached its normal length, but the fluting of the sides still extends to the alveolar border. As attrition goes on, with the advance of the animal in age, the crown-surface wears down, and the neck of the tooth appears above the alveolar border, till, especially in the upper molars, the fluted terminal and the smooth basal portions are of nearly equal extent; but in old age (as in *C*) the smooth basal portion is the longer and the division of the root into fangs is clearly shown. With this wearing down the tooth increases somewhat in both width and length, but the pattern of the enamel folds undergoes but slight change until nearly the whole crown is worn away, except that the angles become gradually more rounded.

Résumé.—As already stated the change with age in the general form of the skull is due to the relatively disproportionate increase in length of the pre- over the post-orbital region, and the same disproportionate increase of the basal region as compared with the frontoparietal elements. In the first case the rostrum becomes relatively greatly produced; in the second the basioccipital and adjoining parts become so greatly enlarged as to change the entire aspect of the basal region of the skull. Thus the occipital condyles, which in *A* terminate slightly in advance of the most convex portion of the supraoccipital, and are crowded up very close to the bullæ, form in *C* the most posterior part of the skull, with a considerable interval between them and the bullæ. (Figs. 12–14, Pl. IV.)

Individual Variation.

In comparing a large series of skulls of the same species it quickly becomes apparent that no element of even the adult skull is constant, either as to form or relative size. There is also much variation in the size of skulls of the same sex and approximately the same age.

Variation in Size.—Thus in *Neotoma micropus*, from the same locality, there are dwarfs and giants. While the females average smaller than the males, size is by no means a safe criterion of sex. Thus two old females, not appreciably different in age, from Corpus Christi, Texas, vary as follows: No. 2948, total length 51 mm., zygomatic breadth 26 mm.; the corresponding dimensions in No. 2955 are 45 mm. and 24 mm. These are merely the extremes of a series of six specimens; with a much larger series doubtless the difference would be considerably increased. A series of six old males, from the same locality and indistinguishable as to age, vary as follows: No. 2952, total length 50.5 mm., zygomatic breadth 27 mm.; the corresponding dimensions in No. 2956 are 45 mm. and 25 mm.

Nasals and ascending branches of the Premaxillæ.—Ordinarily in *N. micropus* the nasals terminate in a gradually narrowed evenly rounded point, a little less than 2 mm. in front of the posterior termination of the ascending branches of the premaxillæ. The distance between the points of termination of the nasals and premaxillæ, however, frequently varies between 1.5 and 2.5 mm.; more rarely from 1 to 3 mm. These extremes each occur in the ratio of about 10 per cent. of the whole, while probably 60 per cent. would not vary much from the normal average of about 2 mm. (See Figs. 1–8 and 16, 17, Pl. IV.)

The nasals, as already said, usually terminate in an evenly rounded point, but in several of the 50 skulls of *N. micropus* before me their posterior border forms a double point, *each* nasal terminating in a distinctly rounded point; in one or two the posterior border is squarely truncate; in others it is irregularly uneven. The ascending branches of the premaxillæ usually terminate in an obtusely V-shaped point, with a uniformly even outline, their breadth, however, being subject to variation; in some specimens they terminate in a brush of irregular spiculæ. (Figs. 1–8 and 16, 17, Pl. IV.)

Frontals.—The posterior border of the frontals is subject to great irregularity, varying from a nearly transverse line (rounded slightly at the outer corners) to a gentle, rather even convexity, and thence to an acute angle, involving the whole posterior border. It is difficult to decide what outline is the most frequent, though the tendency seems to be greatest toward a well-pronounced rather even convexity. Figures 1–8 and 18, 19, Plate V, well show the variation in the position and direction of the fronto-parietal suture.

Parietals.—The anterior outline of the parietals of course conforms to the posterior outline of the frontals, and must be equally variable. It hence follows that their length on the median line is also variable. Their posterior border is also subject to much variation in consequence of the great diversity in the form of the interparietal.

Interparietal.—In middle-aged specimens the interparietal tends strongly to a quadrate form, varying from quadrate to diamond shape, through a more or less marked median angular extension of both its anterior and posterior borders, and occasionally of its lateral borders as well. Often it forms a quadrate figure, in which each of its four sides is slightly convex; again the corners are so much rounded, and the lateral breadth so much in excess of the antero-posterior, as to give a lozenge-shaped figure. In other cases it is distinctly shield-shaped; in others it is hexagonal. In size the variation is fully 50 per cent. of what may be regarded as the average dimensions. These remarks have strict reference to fully adult specimens, and as nearly as can be judged these variations are not at all due to differences of age, which, as already shown, has so great an influence upon the size and form of this exceedingly variable element of the skull.[1] (Figs. 20–23, Pl. IV. Compare also the interparietal, as shown in Figs. 1–8.)

Ventral aspect.—The ventral aspect of the skull presents numerous points of variability, only a few of which will be here mentioned. The palate varies more or less in breadth, and especially in the development of the anterior palatal spine, which is sometimes slight, and sometimes so strongly produced anteriorly as to touch the vomer. The postpalatal border may be evenly concave, or present a slight median process. The presphenoid is very variable in size, being often an exceedingly slender rod of bone, and at other times very stout, the variation in thickness being nearly or quite 100 per cent. The anterior third of the basisphenoid shares in the same variability. As the

[1] As regards variation with age in the form of the interparietal, *Neotoma micropus* is only an example of what doubtless prevails throughout the genus, and even in many other genera as well. Yet in adult animals the form of this bone seems, as a rule, to be sufficiently constant to be of more or less taxonomic value. Thus in the *N. cinerea* group it may be said to be normally quadrate; in the *N. fuscipes* group it is quite constantly shield-shaped. In *N. floridana*, however, and in the *N. mexicana* group, it seems to be nearly or quite as variable as in *N. micropus*, both as to size and shape.

ascending borders of the palatals are also variable in respect to the extent of their development, it follows that there is, even among adults, a wide range of variation in the size of the spheno-palatine vacuities.

Teeth.—Aside from differences due to age and attrition, the teeth vary in size to a considerable extent among individuals strictly comparable as to sex and age, some having a much heavier dental armature than others. But more particularly noteworthy in this connection is the variation in the color of the teeth, which seems strongly a matter of individuality. Although Dr. Merriam has recently placed *N. micropus* in his "*Neotoma leucodon* group,"[1] which has, among other alleged characters, "color of teeth white or nearly white," the teeth in *N. micropus* average blacker than in any other species of the genus known to me. Were this all it might be considered that *N. micropus* was erroneously referred to the '*leucodon* group'; but unfortunately the range of individual variation in the color of the teeth in the large series at hand covers also the whole range of variation for the genus. Thus in some instances the molar teeth are intensely black from base to crown, while the crown-surface itself is strongly blackish, even the enamel loops, as well as the enclosed dentine being tinged with blackish; in other cases the teeth are merely slightly tinged with brownish near the base and at the bottom of the sulci. These extremes are connected by a series of very gradual intergradations. In other words, among hundreds of skulls of *Neotoma*, those with the blackest teeth occur in *N. micropus*, as well as those in which the teeth are practically white.

In the suckling young the teeth are pure white; before M.3 has come to wear, M.1 and M.2 have become more or less blackened; in young adults, and in middle aged specimens, the teeth are often intensely black; in old specimens, with the teeth much worn, the teeth average lighter than in the younger individuals. There is, however, a wide range of variation in the color of the teeth in specimens of corresponding age, whether old or young. The black coloring consists to a large extent of a

[1] Proc. Biol. Soc. Wash., IX, p. 118, July 2, 1894.

superficial incrustation which tends to scale off in flakes in the prepared skull, and its absence apparently may be due sometimes to removal in the process of cleaning the skull for the cabinet. In other words, the blackness is to some extent an accidental or pathological condition, due probably more or less to the particular character of the food or to the health of the animal.

General Remarks.

The bearing of what has been stated above respecting variations in the form of the skull and of its principal elements due to age is of course obvious, the inference being that in animals which have reached sexual maturity variations due wholly to growth, in passing through adolescence to senility, may readily be mistaken, when working with very small series or with single specimens, for differences of subspecific or even specific importance. Not only do the individual bones vary in their outlines and proportions and in relative size, but the skull varies as a whole in its relative dimensions, including depth as well as length and breadth. There is beside this a wide range of purely individual variation, affecting every character that can be used in a diagnostic sense. Thus in a series of fifty skulls of *Neotoma micropus* it would be easy to select extremes, of even individual variation, that depart so widely from the average, in one or more characters, as to deceive even an expert, on considering these alone, into the belief that they must represent very distinct species; yet in the present instance the proof that such is not the case is overwhelming. In *N. micropus* the coloration is remarkably constant, for a member of this genus, at all seasons and ages, so that the case is less complicated than it would be in many other species of the group, where the color of the pelage varies radically with season and age.

Personal criticism is not the purpose of the present paper, and it was not my intention at the outset to refer specifically to the work of any of my *confrères*. Since its preparation was begun, however, its *raison d'être* has perhaps been emphasized by the publication of two brochures of 'preliminary descriptions' of species and subspecies of the genus *Neotoma*, numbering altogether 10 species and 8 subspecies, which added to the 22 species and subspecies previously standing practically unchallenged, makes, at the present writing, a total of 40 forms of the genus *Neotoma*. Of these no less than 26 have been described within the last nine months.[1] Without the material before me used by the original describers of these forms it would be presumptive to give an opinion respecting the merits of many of them. While the greater part may have some real basis, it is evident that others are almost unquestionably synonyms of previously-described forms, judging by 'topotypes' in this Museum, the brief diagnoses accompanying the names affording in these cases no characters that are in the least degree distinctive.

The genus *Neotoma* was chosen for treatment in this connection in preference to some other almost solely by chance, as the facts of variation above presented are not at all exceptional. In fact the common muskrat (*Fiber zibethicus*) would have shown a still more striking case of variability, as would also various species of many other genera. Yet describers of new species are constantly laying stress upon cranial differences that have not necessarily the slightest specific or even subspecific importance; and, so far as can be judged from their descriptions, they are entirely unconscious that such can be the case.

On the other hand, it is equally certain that such alleged characters may have the value assigned them; since it is now a well known fact that the extremes of purely individual variation in any character, external or internal, may exceed in amount the average differences that serve to satisfactorily distinguish not only well-marked subspecies, but even forms that are unquestionably specifically distinct. Hence it must often happen that the determination of the status of a species or subspecies originally described from one or two specimens, in groups especially susceptible to variation, must depend upon the subsequent examination of a large amount of material bearing upon this and its closely-related forms.

[1] For a list of the species and subspecies of *Neotoma* described prior to July 6, 1894, see Abstr. Proc. Linn. Soc. New York, No. 6, pp. 34, 35, July, 1894.

EXPLANATION OF PLATE IV.

Figures all Natural size.

Neotoma micropus *Baird.* Showing cranial variations due to age and individualism. (Unless otherwise stated, the specimens are from Rockport, Texas.)

Figs. 1–8. Dorsal aspect of skull, showing gradual change in form with age, and especially in the form and relative size of the interparietal. Fig. 1, No. 5834, ♀ juv. (suckling). Fig. 2, No. 2975, ♀ juv. (nearly sexually adult), Corpus Christi, Texas. Fig. 3, No. 5841, ♀ ad. Fig. 4, No. 4480, ♂ ad. Fig. 5, No. 2958, ♂ ad., Corpus Christi. Fig. 6, No. 4479, ♂ ad. Fig. 7, No. 4477, ♀ ad. Fig. 8, No. 4478, ♂ ad.

Figs. 9–11. Skull in profile, to show change of form with growth. Fig. 9, No. 5834, ♀ juv. (nursling). Fig. 10, No. 4480, ♂ ad. (rather young). Fig. 11, No. 4478, ♂ ad. (very old).

Figs. 12–15. Ventral aspect, showing variations in postpalatal region due to age. Fig. 12, No. 5834, ♀ juv. (nursling). Fig. 13, No. 5841, ♀ ad. (young adult). Fig. 14, No. 2958, Corpus Christi, ♂ ad. (very old). Fig. 15, No. 1456, *Neotoma cinerea occidentalis*, ♂ ad., Ducks, B. C. (for comparison with *N. micropus*).

Figs. 16, 17. To show extremes of individual variation in relative posterior extension of nasals and ascending branches of premaxillæ. Locality, Corpus Christi, Texas. Fig. 16, No. 2958, ♂ ad. Fig. 17, No. 2948, ♀ ad.

Figs. 18, 19. To show extremes of individual variation in posterior border of frontals. Locality, Corpus Christi, Texas. Fig. 18, No. 2949, ♂ ad. Fig. 19, No. 2951, ♂ ad.

Figs. 20–23. To show individual variation in the size and form of the interparietal. Specimens all from Corpus Christi, Texas. Fig. 20, No. 2949, ♂ ad. Fig. 21, No. 2948, ♀ ad. Fig. 22, No. 2952, ♂ ad. Fig. 23, No. 2945, ♀ ad.

NOTE.—If the Brownsville, Texas, series of specimens had also been included, the range of individual variation would have been considerably increased.

Article X.—REMARKS ON SPECIMENS OF CHILONYCTERIS RUBIGINOSUS FROM WESTERN MEXICO, AND ON THE COLOR PHASES OF PTERONOTUS DAVYI GRAY.

By J. A. Allen.

The Museum has recently received from Dr. Audley C. Buller a small collection of Bats from the south shore of Lake Chapala, in the State of Michoacan, Mexico, among which are four specimens, referable to *Chilonycteris rubiginosus*. As the specimens have been freshly collected, and still retain the natural coloration of the membranes (not usually given in published descriptions), I append the following description based on them.

Pelage short, rather thin and very fine; above dull brown, the fur uniform in color throughout; below somewhat lighter grayish brown, the fur being slightly tipped with grayish. Ears and membranes everywhere pale brown, except the ventral surface of the interfemoral membrane, which is whitish or lead-colored. Alar and interfemoral membranes edged with whitish, forming a conspicuous border when seen from below, especially on the front edge of the alar and posterior edge of the interfemoral. Ears not white-edged, but whitish externally at the base. Membranes naked, except for a slight hairiness on the basal portion of the upper surface of the interfemoral. Ears naked externally except at the base; internally with a few scattered hairs.

The four specimens, all males, vary but little in size, the forearm ranging in length from 53 to 57 mm. This is considerably smaller than the measurements of *C. rubiginosa*, given by authors.

C. rubiginosa has been reported from Dueñas, Guatemala, and also from Mirador (near Vera Cruz) in Mexico, the latter locality hitherto resting on a MS. list of Mexican Bats in the National Museum (*cf.* Alston, Biol. Cent. Am., Mam., p. 36). Through the kindness of Mr. Frederick W. True, Curator of Mammals in the United States National Museum, these specimens (Nat. Mus. Nos. 6181, ♂, and 6180, ♀, Mirador, Mexico, Dr. Sartorius) are now before me. They agree very nearly in size with the larger examples of the Lake Chapala series, but are radically different in color, being light reddish brown instead of dusky or blackish brown. The forearm measures 55 mm. in the female, and 59 mm. in the male, as against 53 to 57 mm. in the four males from Lake Chapala, and 62.2 mm. as given for this species by Dobson. Notwithstanding the smaller dimensions of the northern specimens, in view of the reputed wide range in color variation shown in this species, I deem it best to refrain from naming the Mexican animal, even subspecifically, especially in the absence of material from more southern points for comparison.

Note on Pteronotus davyi Gray.—With the four specimens of *Chilonycteris* above described were four examples of *Otopterus bulleri* (H. Allen) and six of *Pteronotus davyi.* These latter are of particular interest, inasmuch as they represent two widely different color phases, which are evidently independent of sex, age or season. The six specimens are all adult males except one, which is an adult female. Three of the males are in the "brilliant fulvous-chestnut" phase, for which Mr. Oldfield Thomas has recently proposed the subspecific name *fulvus* (Ann. and Mag. Nat. Hist., Ser. 6, X, p. 410, Nov., 1892); the other two males and the female are in the dark reddish brown dress of the ordinary Trinidad form of *davyi.* The length of the forearm ranges in the five males from 43 to 45 mm., the largest just equaling that of a single male specimen in Mr. Chapman's collection from Trinidad. Hence these specimens appear to conform closely in size with Mr. Thomas's series (l. c.), in which the forearm varied from 42.5 to 45 mm.

The single specimen (♂) previously recorded by me from the Plains of Colima (this Bulletin, III, p. 178, Dec., 1890) agrees also in coloration with Trinidad specimens; so that of the 12 specimens recorded by Mr. Thomas and myself from Mexico, four are colored as in Trinidad specimens and eight are of the "brilliant fulvous chestnut" type. It therefore seems doubtful whether this color difference is of subspecific importance. The smaller size of the northern examples appears to be parallel with what occurs in *Chilonycteris rubiginosus*, as above recorded.

Article XI.—NOTES ON SOME SPECIES OF NORTH AMERICAN ORTHOPTERA, WITH DESCRIPTIONS OF NEW SPECIES.

By William Beutenmüller.

In advance of a descriptive catalogue of the Orthoptera found within a radius of fifty miles of New York City and adjacent districts, the following notes and descriptions of some apparently new species are presented.

Nemobius affinis, sp. nov.

Shining, head and thorax fusco-testaceous or wholly piceous and sparsely covered with rather long hairs. Antennæ longer than the body. Wing covers of the female not reaching the tip of the abdomen, and with a paler line along the angle where the wing covers turn down at the sides. In the male the wing covers extend to the tip of the abdomen. Hind wings absent in both the sexes. The abdomen above is blackish, with faint traces of some paler spots; on the underside the body is wholly testaceous, as are also the legs, but somewhat darker. Anal cerci extending beyond the ovipositor, which points obliquely upwards. Length of body about 6–8 mm.; ovipositor of female, 3–4 mm.; cerci, 3.5–4 mm.

Types: males and females, Coll. Am. Mus. Nat. Hist.

Collected in Connecticut and different places in the vicinity of New York City; also taken in abundance on Staten Island by Mr. Davis.

Closely allied to *Nemobius fasciatus*, form *vittatus*, but smaller and more shining. It also differs by the shortness of the ovipositor, it being about one-half as long, and by having the abdomen wholly testaceous beneath. The stridulation is a long, continuous, soft, rolling *whirrrrrr*. The insect occurs from the latter part of July until frost. It is found in the same places as *Nemobius fasciatus*, and is rather common.

This is the species described by Mr. W. S. Blatchley in the Proceedings of the Indiana Academy of Sciences, 1891, p. 136, as *Nemobius exiguus* Scudder. Dr. Scudder did not describe an insect under this name, but simply refers to Say's *Acheta exigua*

(Bost. Soc. Nat. Hist., Vol. VII, 1862, p. 429). Say's description of this latter species agrees fairly well with the little Cricket known to us at present as *Anaxipha pulicaria* (Burm.). This latter species was described from Jamaica, and is probably different from *Anaxipha exigua.*

Œcanthus nigricornis *Walker.*

Œcanthus fasciatus DE GEER, FITCH, Rep. Nox. Ins. N. Y. Trans. N. Y. Agricul. Soc. 1856, p. 414 (in error).

Œcanthus nigricornis WALKER, Cat. Derm. & Saltat. Brit. Mus. Gryllidæ, 1869, p. 93.

The description of *Œcanthus nigricornis* Walker agrees very well with the long-winged form of the species described by Fitch under the name of *Œcanthus fasciatus* De Geer. Fitch, however, erroneously mistook his insect for DeGeer's *Gryllus fasciatus*, which is a *Nemobius.* Consequently he did not give a name to his species, and Walker's name *nigricornis* should be used.

It is jet black with yellowish green elytra and wings. The first two joints of the antennæ have two black marks on each, those on the first joint usually confluent at the apex. These marks are mostly always obscured by the black ground color of the antennæ. It is found on low bushes in open fields and roadsides, and stridulates in the hottest sunshine. The stridulation is a long and comparatively loud, continuous *whirrrrrr*, often lasting several minutes.

Œcanthus 4-punctatus, sp. nov.

This name is proposed for the wholly pale green species with two black marks on the underside of the first two basal joints of each antenna, the innermost mark on the first joint nearly as long as the joint, and the outer one in shape of a spot; on the second joint the marks are oblong and nearly equal. The antennæ are fuscous except the basal joint, which is pale green. The insect is at present known to us as a variety *Œ. nigricornis.* It is certainly distinct, since it does not breed together with *nigricornis.* Amongst the many individuals collected or observed by me in the field in *coitu*, I have never been able to find *Œ. 4-punctatus* in *coitu* with *Œ. nigricornis*, but always found the two species breeding separately.

Measurements.—Male: Length of body, 10 mm.; pronotum, 2.5 mm.; wing covers, 11 mm.; hind femora, 7.5 mm.; width of wing covers, when folded, 5 mm. Female: Length of body, 10 mm,; pronotum, 2.5 mm.;

wing covers, 10 mm.; hind femora, 7 mm.; width of wing covers, when folded, 3 mm.

Lives on low bushes in open fields, and the stridulation is the same as that of *Œ. nigricornis.*

Œcanthus angustipennis *Fitch.*

Fitch's description of *Œ. angustipennis* is entirely too brief for recognition of the species he intended to describe. It applies equally as well to *Œ. 4-punctatus* as to the insect determined by recent writers as *Œ. angustipennis.* Whether the latter has been correctly determined or not can never be definitely ascertained, as Fitch's type of the species, as well as all his other species of *Œcanthus*, have been destroyed. I would propose that the name *Œ. angustipennis*, nevertheless, be retained for the species so well known to us by this name. It may be easily recognized by being wholly pale greenish white, with the wing covers narrow, and by having one black mark on each of the first two basal joints of the antennæ; the one on the first joint elongate and hooked at the base, with the hook turned inwards; and the mark on the second joint shorter and slightly curved. The stridulation is a faint continuous *reeeeeé*, lasting about five seconds, and terminating abruptly, and with an equal interval of rest. It inhabits the high branches of trees, and is very seldom found on low bushes and shrubs. It stridulates late in the afternoon and by night.

Scudderia fasciata, sp. nov.

Head green, with a white line in front and a yellowish mark at the sides; basal joint of antennæ green, following joints testaceous, becoming darker towards the extremity; pronotum dark grass green, paler at the side, and a rather broad yellow stripe along the lateral carina; wing covers dark grass green with a yellowish brown line running along the inner margin, and preceded by a blackish line running from the base to the apex; another blackish line runs along the costal vein; hind wings transparent, veins green and a green patch at the apex with a blackish dash; sides of abdomen green, above purplish; underside with a white and purplish stripe on each side, green along the middle; tip of anal spines of the male and ovipositor of female reddish brown; anterior legs green, femora testaceous at base; middle legs green; hind legs green, with the femora marked with black outside; tibiæ with black spines; tarsi of all the legs purplish brown; the anal spines are like those of *S. angustifolia* and *S. furcata.*

Measurements.—Male: Length of body, 18 mm.; pronotum, 4 mm.; posterior femora, 18 mm.; wing covers, 25 mm. Female: Length of body, 21 mm.; pronotum, 4 mm.; posterior femora, 17 mm.; wing covers, 21–23 mm. Expanse, male, 61 mm.; female, 50 mm.

Types: three males and three females, Coll. Am. Mus. Nat. Hist. Collected at West Woodstock, Windham Co., Conn., on pine trees, September.

Scudderia truncata, sp. nov.

Somewhat resembles *Scudderia pistillata* in general appearance, but is considerably smaller. The wing covers are narrower and of almost equal width, with the costal margin curved; apex rounded; the eyes are larger and more protruding; pronotum narrower in front than behind, not much longer than broad. Supra-anal plate of male with no elongated process, but abruptly pointed with the apex truncate and minutely notched. The subanal process is long and slender, and abruptly turned upwards; much less curved than that of *S. pistillata*.

Measurements.—Male: Length of body, 15 mm.; wing covers, 26 mm.; posterior femora, 19 mm.

Described from a single male taken by the late Henry Edwards at Vineland, N. J. Type, Coll. Am. Mus. Nat. Hist.

This is probably the insect referred by Brunner von Wattenwyl to *Scudderia angustifolia* Harris (Monograph Phaneropteriden, 1878, p. 241). His description of the insect agrees with the specimen before me. Harris's *angustifolia*, however, was recently determined for me by Prof. Lawrence Bruner and Mr. W. S. Blatchley, and their determinations are alike, but differ from Brunner von Wattenwyl, and I am inclined to believe the former are correct. Harris's *angustifolia* is allied to *S. furcata*, while *S. truncata* is allied to *S. pistillata*. The figure of *angustifolia* in Harris's 'Report on Insects Injurious to Vegetation' agrees better with Bruner's and Blatchley's determinations than it does with that of Brunner von Wattenwyl.

Melanoplus punctulatus (*Scudder*).

The habits of this species are very different from those of the other members of the same genus. Instead of being an active creature, and living on the ground amongst grass like other species of *Melanoplus*, it inhabits pine trees, and is sometimes found in numbers on the same tree. It is quite sluggish, and may be easily taken without it making any or much effort to escape capture. Found during August and September.

Article XII.—DESCRIPTIVE CATALOGUE OF THE ORTHOPTERA FOUND WITHIN FIFTY MILES OF NEW YORK CITY.

By William Beutenmüller.

The object of the present paper is to enable those interested in the study of Orthoptera to determine the species found within a radius of fifty miles of New York City. Reference has also been made to those species which are likely to occur in this district.

The descriptions of the species and genera have all been taken from specimens in the collection of the American Museum of Natural History, and have in most cases been compared with the original descriptions and quotations taken therefrom.

Much assistance has been rendered me by the following gentlemen, to whom I herewith desire to express my sincere thanks for their kindness and readiness in aiding me in my work.

Mr. Wm. T. Davis for list of species and loan of specimens found on Staten Island; Prof. John B. Smith, of New Brunswick, N. J., and Mr. Nathan Banks, of Sea Cliff, L. I., for lists of species taken by them in their respective localities; Mr. A. P. Morse, of Wellesley, Mass., for list of Acrididæ of New England, and presentation of specimens of *Opomala brachyptera*, *Stethophyma lineata* and different species of *Sph".concat("aragemon*, including types of his *S. saxatile* and *S. æquale scudderi*; Mr. Blatchley, of Terre Haute, Ind., for specimens of *Scudderia*, and Dr. S. H. Scudder and Prof. Lawrence Bruner for identification of doubtful species. The plates were drawn from nature by Mr. L. H. Joutel, and the figures in the text by Mr. R. L. Ditmars.

In order to properly understand the terms used in this paper, it has been thought advisable to insert the following cut, which was redrawn from the First Report of the U. S. Entomological Commission, p. 258.

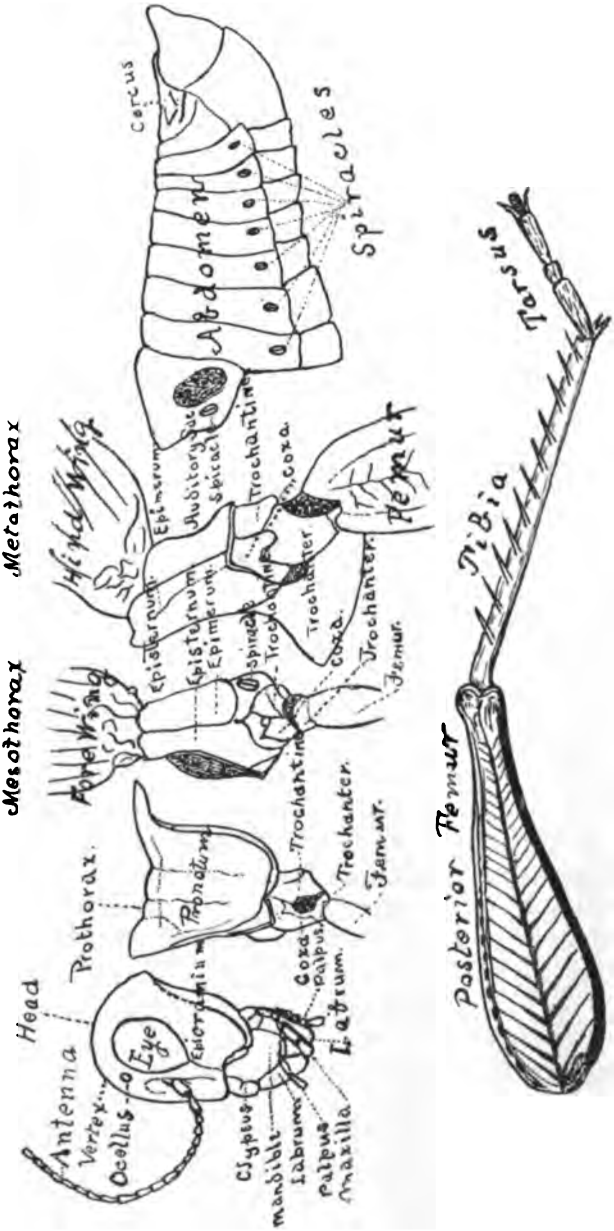

FIG. 1 External Anatomy of *Melanoplus spretus.*

FORFICULIDÆ.—Earwigs.

The members of this family may be known by their long, slender and flattened bodies, with the sides almost parallel, and the last abdominal segment furnished with a pair of forceps. Wings and wing covers present or absent.

Anisolabis *Fieber.*

Body long and slender, without wings, and of nearly equal width throughout; antennæ about half as long as the body, about 19-jointed. First and third tarsal joints of about equal length; second joint much smaller; forceps rather stout, slightly curved.

Anisolabis maritima (*Bonnell*).

Plate V, Fig. 1.

Deep blackish brown, shining; underside considerably paler; legs pale luteous, also the antennæ at the base, and becoming darker towards the tip. Length, 15–22 mm.; forceps, 3–4 mm. Width, 3–4 mm.

Rather common at Sandy Hook, N. J., and along the banks of the Hudson River; also taken along the sea shore of Long Island and on Staten Island. Ranges throughout nearly the whole temperate and tropical world. Found under sticks, stones and rubbish during July and August.

Spongophora (*Serville*).

Body long and slender, flattened, with the sides of the abdomen straight; antennæ over half the length of the abdomen, 15–20-jointed, with the joints rather long; wings and wing covers present. First tarsal joint longer than the second and third together; third joint scarcely longer than the second; forceps nearly straight, very long and with a few teeth on the inner edge in the male; nearly unarmed in the female.

Spongophora brunneipennis (*Serville*).

Head, thorax and wing covers blackish brown; abdomen rich chestnut brown; wings yellowish, edged within and at the apex with dark chestnut brown; palpi luteous; antennæ 14–15-jointed, darker than the palpi; legs honey yellow; forceps simple, straight, incurved at the tip and half as long as the abdomen, with a quadrate basal tooth (female) or two-thirds as long as the abdomen, with a more or less prominent inner tooth before the middle. Length, 9 mm.; forceps, 3–4 mm.

Recorded from New Jersey, Pennsylvania southward to Mexico, and is probably also found in this vicinity.

Forficula *Linnæus.*

Body more or less flattened, usually long and slender; antennæ generally a little more than half as long as the body, 10–14-jointed, the joints cylindrical, scarcely longer at the apex than at the base, seldom less than four times as long as broad; wing covers present; wings sometimes present; first tarsal joint a little longer than the third, the second broadened at the apex and passing beneath the third joint; forceps of varied construction.

Forficula aculeata *Scudder.*

Dark chestnut brown; palpi and legs luteous; thorax longer than broad and narrower than the head, the sides pale luteous; wing covers nearly twice as long as the thorax, luteous, and broadly margined inwardly with deep chestnut brown; hind wings considerably shorter than the wing covers; male forceps about three-fourths as long as the abdomen, slender, arcuate, bent downward beyond the middle and again horizontal to the tip, before which is also a short tooth; pygidium with a long sharp point. Length of body, male and female, 9–11 mm.; forceps of male, 4–5 mm.; female, 2.5 to 3.5 mm.

Rare in this vicinity. Taken in May on Snake Hill, N. J., under stones. It probably also occurs in other localities in this vicinity.

Forficula pulchella *Serville.*

Head blackish; antennæ brown, paler at base; thorax brown, with the sides and hind margin paler; wing covers brown; wings yellow edged with brown; abdomen reddish brown; forceps of male arcuate in the middle, pointed, with an inner tooth near the base. Length of body, 8 mm.; forceps of male, 5 mm.; female, 2.5 mm.

Recorded from Niagara, N. Y., and will probably also be found in this vicinity.

Forficula auricularia *Linnæus.*

Fusco-ferruginous; antennæ 14–15-jointed; basal joint, sides of thorax and legs testaceous; wings and wing covers dull luteous, the latter half as long again as the pronotum; forceps of male usually as long as the abdomen, horizontal, depressed, and dilated at the base, and beyond rather strongly arcuate, tapering to a point, the extreme base of inner edge tuberculate-denticulate, with a distinct inner tooth at base of the arcuate portion. Body about 11 mm.; forceps, male, 4–8 mm.; female, 3 mm.

This species has been recorded from New York and New Jersey. It is also found in Cuba, Para, Europe, North Africa, West Asia and Madeira.

Labia *Leach.*

Size small; body long and flattened; antennæ about half as long as the body, 10–13-jointed; the joints rarely more than three times as long as broad; wing covers present; wings present or absent; first and third tarsal joints of equal length; second joint very small, simple and compressed; forceps about half as long as the abdomen, in the male, simple, curved; in the female, straight and incurved at the tip.

Labia minor (*Linn.*).

Much smaller than any of the preceding species. Light brown, pubescent; head blackish; antennæ 10–12-jointed, fuscous; mouth-parts pale; pronotum narrower than the head, and a little longer than broad; wing covers nearly twice as long as the thorax; hind wings as long as the pronotum; legs pale luteous; abdomen reddish brown in the middle above; forceps of male more than half as long as the abdomen, and distantly serrulate on inner edge; last segment of male with an apical, compressed, upcurved, long and slender tubercle. Length of body, 3.75–6 mm.; forceps, 1.25–2 mm.

Quite rare in this vicinity; May and June. Found from Maine to Texas; also in Europe, Siberia and Madeira.

Synopsis of Species of Forficulidæ.

Anisolabis.

Wing covers and wings wanting.
    Legs testaceous..*A. maritima.*

Spongophora.

First tarsal joint longer than the other two together; wing covers and wings present.
    Forceps shorter than the pronotum, wings and wing covers together ....*S. brunneipennis.*

Forficula.

Second tarsal broad at apex, lobate and passing beneath the third joint.
    Last segment with a long sharp point.....................*F. aculeata.*
    Forceps of male with a basal tooth on the inner edge........*F. pulchella.*
    Forceps of male with an inner tooth at the arcuate portion, *F. auricularia.*

Labia.

First and third tarsal joints equal; second, minute and compressed.
    Last segment of male with a long apical tubercle..............*L. minor.*

BLATTIDÆ.—COCKROACHES.

May be known by having the body elongate or broad and depressed; the pronotum shield-like, and the head bent down and sloping backwards. The legs are well developed for running, and are furnished with numerous spines. The wing covers overlap when at rest. Antennæ long and slender.

Phyllodromia *Serville.*

Body longer than broad; abdomen not broader than the thorax; sides of body almost parallel in the female and slightly narrowing from the base in the male; wing covers extending to the tip of the abdomen or a little beyond. Supra-anal plate truncate in the male; pointed and notched in the female.

Phyllodromia germanica (*Linn.*).

Yellowish brown, head and antennæ somewhat darker. The wings extend to the tip of the abdomen. On the thorax are two dark-brown longitudinal stripes. Length about 16 mm.; width, 4 mm.

This is the common small Roach which is so abundant in dwelling houses. It is commonly known as the Croton or Water Bug. It was imported from Europe during the time of the introduction of our Croton-water system, finding its way along the pipes from house to house. The eggs are laid in a capsule, containing about thirty-six eggs, attached to the end of the abdomen of the female. The insect is fond of warm places, especially around fireplaces and warm-water pipes. It breeds with great rapidity, and there are probably four broods a year in this vicinity.

Ichnoptera *Burmeister.*

Allied to *Periplaneta*. Abdomen elongate, slender, not wider than the thorax, sides almost parallel, tapering towards the end of body; wing covers much longer and broader than the abdomen. Anal plates rounded; subanal plate with two minute stylets bent downwards. Legs spined, but not as strongly as in *Periplaneta*. Antennæ about as long as the body.

Ichnoptera unicolor (*Scudder*).

Entirely uniform pale yellowish brown, without any markings whatever. The eyes are pitchy black, and the antennæ are slightly darker than the wings. The wings extend considerable beyond the abdomen. Length of body, 12 to 15 mm.; expanse of wings, 32 to 40 mm.

Found in woods under loose stones and the bark of trees during the day, and flying at light at night in June. The insect is very active when disturbed, and produces a crackling noise by rubbing its wing cases together.

Ichnoptera pennsylvanica (*De Geer*).

Much larger and darker in color than the preceding species. The median vein of the fore wings, dark; hind wings translucent, yellowish brown along the costa, veins dark; thorax dark brown, with a broad light border. Length about 16 mm.; expanse of wings about 50 mm.

Not common in woods under stones and loose bark of trees in June. Like the preceding species this species also produces a crackling noise when disturbed.

Periplaneta *Burmeister*.

Size large. Wings strongly developed, as long or longer than the abdomen. Subanal stylets long; anal plates truncate or pointed. Legs with long spines. Thorax as broad as the abdomen, narrower in front than behind, with the angles well rounded. Antennæ much longer than the body.

Periplaneta americana (*Linn.*).

PLATE V, FIG. 4.

Reddish brown; thorax pale with two reddish brown patches. The wings are well developed in both sexes, and extend beyond the end of the abdomen. Legs somewhat paler than the body. Antennæ much longer than the body, and extending beyond the tips of the wings. Length of body about 27 to 30 mm.; expanse of wings about 60 to 70 mm.

This is the largest species of Cockroach found in this vicinity. It inhabits houses, especially bake-shops, and feeds upon nearly everything. The wings are well developed, and adapted for flight.

Stylopyga *Fischer.*

Differs from *Periplaneta* in having the wings and wing covers in the female rudimentary, and in the male much shorter than the abdomen ; the outer border of the anterior pair of wings is also less rounded than in *Periplaneta.*

Stylopyga orientalis (*Linn.*).

PLATE V, FIGS. 2 AND 3.

Deep chestnut brown or piceous, with the legs and underside of body somewhat paler. The wings of the males do not reach the tip of the abdomen. The wings are absent in the female, and the wing covers are rudimentary. Length, about 22–27 mm.

This insect is sometimes one of the most disgusting household pests. It is nocturnal in habit, and feeds upon almost anything. It differs from *P. americana* by having the wings not reaching the tip of the abdomen in the male, and aborted in the female.

Panchlora *Burmeister.*

Abdomen broad, flattened, sides evenly rounded, anal plates notched. Thorax about as wide as the first abdominal segment, narrower in front than behind, angles well rounded, sides flattened. Antennæ about half as long as the body. Wings reaching the tip of the abdomen or a little longer ; tarsi spined ; femora unarmed.

Panchlora viridis (*Fabr.*).

Head pale yellowish green ; eyes brown. Thorax and body pale green, the former with a yellow band on each side before the margin, and the latter with a yellow shade along the back. Underside of body and the legs pale greenish white; wing covers semi-transparent, veins pale green, with a white basal streak, running below the anterior margin to nearly the middle of the wing. Hind wings transparent, with the veins also pale green. Length of body, about 18 mm. ; width, 8 mm.

This West Indian species is occasionally found in this vicinity, and may be easily recognized by its pale green color.

Ectobia *Westwood.*

Body about twice as long as broad ; wing covers scarcely reaching the tip of the abdomen ; subanal stylets of males absent ; antennæ longer than body ; supra-anal plate pointed ; subanal plate truncate, angles rounded.

Ectobia borealis (*Saussure*).

Body broad and stout, pitchy brown below, lateral edge light brown. Wing covers scarcely reaching the tip of the abdomen ; hind wings about half the length. Thorax broader than long, much rounded at the sides, chestnut brown, broadly margined in front and at the sides with yellowish white. Antennæ as long as the body. Head pitchy brown with light markings. Legs light brown with the spines darker. Wing covers chestnut brown with a rather long yellowish brown basal streak running along the anterior margin to about the middle of the wing. This light line is only dimly visible in dried specimens. Length, 16 to 20 mm. Width of body, about 7 to 8 mm. Width of thorax, 6 to 7 mm.

Not rare in this vicinity in woods under stones and bark. June and July.

Temnopteryx *Brunner.*

Abdomen almost as broad as long ; anal plates pointed ; thorax somewhat narrower than the abdomen, much narrower in front than behind, anterior angles well rounded, posterior angles acutely rounded. Wing covers very short ; hind wings rudimentary.

The species of this genus very much resemble larval forms of other species of *Blatta.*

Temnopteryx virginica *Brunner.*

Head and body above chestnut brown or piceous ; thorax bright chestnut ; legs and underside of thorax luteous ; underside of body lighter than above ; wing covers about one-third as long as the abdomen. Length, 8–12 mm. Width, 5–6 mm.

Common in woods under stones from April until September.

Synopsis of Species of Blattidæ.

Phyllodromia.

Body narrow, wings reaching the tip of abdomen.
Thorax with two dark brown stripes.................... ...*P. germanica.*

Ichnoptera.

Wing covers much broader and extending considerably beyond the body.
Size small; uniformly yellowish brown...........................*I. unicolor.*
Size large; thorax dark brown, with light border........*I. pennsylvanica.*

Periplaneta.

Wings well developed, extending beyond the abdomen; legs with strong spines.
Chestnut brown; thorax pale, with two chestnut brown patches, *P. americana.*

Stylopyga.

Wings not reaching tip of abdomen in the male; rudimentary in the female.
Wholly deep chestnut brown or piceous...... ....*S. orientalis.*

Panchlora.

Abdomen very broad and flattened; antennæ shorter than the wing covers.
Pale green, thorax with a yellow stripe on each side; wing covers with a white basal streak ....*P. viridis.*

Ectobia.

Body twice as long as broad; wings reaching the tip of abdomen, antennæ longer.
Thorax with a broad pale border; wing covers with a pale basal streak........... ....*E. borealis.*

Temnopteryx.

Wing covers about half as long as the abdomen.
Wholly chestnut brown or piceous.... .. ..*T. virginica.*

PHASMIDÆ.—Walking Sticks.

Diapheromera *Gray.*

Wingless; body stick-like, very long, slender, narrow and of almost equal width throughout; antennæ very long and thread-like; legs long and graceful; femora of middle legs swollen and provided with a prominent spine, in the male.

Diapheromera femorata (*Say*).

Plate X, Fig. 10.

Wholly green, greenish or varying from very light to dark chocolate brown. Length, 65-85 mm.

This insect is popularly known as the Walking Stick. It is found in this vicinity during the latter part of August and in September, and is not rare. It feeds on the foliage of hazel, oak, hickory, locust and other trees and shrubs. The eggs are gray, oval in outline, and are dropped loosely on the ground in autumn and hatch the succeeding year. When at rest the insect mimics a green twig or dead branch.

GRYLLIDÆ.—CRICKETS.

The Gryllidæ may be known by their large globose head, with long thread-like antennæ. The wing covers are rather flat on top and abruptly bent downwards at the sides ; except in *Gryllotalpa* and *Tridactylus*, which have the wing covers oval, and the fore tibiæ very broad and toothed ; the other species have the anterior legs slender, and the posterior femora stout and swollen, except in *Œcanthus* where they are rather slender. The hind wings are folded when present ; and the wing covers of the males are provided with a stridulating organ.

Tridactylus *Oliver.*

Body glossy. Head and pronotum convex ; eyes oval ; antennæ short ; wing covers not reaching the end of the body ; wings longer or shorter, folded lengthwise like a fan. Anterior tibiæ broad and flat, armed at the end with four spurs ; all the tarsi very slender ; posterior femora long and broad, with a rounded shallow depression at the end. Body narrower than the thorax.

Tridactylus terminalis *Scudder.*

PLATE V, FIG. 15.

Head and thorax pitchy black, glossy, sometimes with reddish brown spots. The hind femora are black with two white spots or fasciæ. The wings reach to the tip of the abdomen, or extend a little beyond, in both sexes. Length about 7 mm.

Found from May to September in damp situations. The insect burrows perpendicularly in the ground ; the channel expanding at the bottom. According to Mr. Wm. T. Davis it is very difficult to capture, owing to its marvelous agility. The power of leaping is so great that it seems to disappear quite mysteriously, and one wonders which way it has gone, it being seldom that the departure can be accurately followed by the eye.

Gryllotalpa *Latreille.*

Head oval; thorax convex, sub-ellipical, sides rounded; body rounded and about twice as long as the thorax; anterior legs very stout and strong, broad and flattened, with four long spines at the tip and a movable claw-like organ outside, with two spines; middle legs short and slender; hind legs longer. Wing covers about half as long as the abdomen; hind wings half as long or longer than the abdomen.

Gryllotalpa borealis *Burmeister.*

Cinnamon brown, covered with short, fine hairs of the same color. The wing covers are less than one-half as long as the abdomen, and the hind wings extend a little beyond the wing covers. Length, about 30 mm.

This insect is commonly known as the Mole Cricket, so called from the enlarged fore feet, head and thorax, which wonderfully mimic a mole. It lives in damp places, especially along the borders of ponds and sandy banks of streams, where it burrows in the ground, and forms long channels with raised ridges, which very much resemble a miniature mole hill. The eggs are deposited in masses of from 200 to 300 in a round cavity deeper in the ground.

Gryllotalpa columbia *Scudder.*

PLATE V, FIG. 5.

Differs from the preceding species by having the upper wings somewhat longer, and the hind wings extending beyond the tip of the abdomen. Length, 30–35 mm.

The habits are the same as in *G. borealis*, but the insect is less common, and it is probably nothing more than a long-winged variety.

Gryllus *Linnæus.*

Body stout; head large and globose; eyes large and rounded; antennæ thread-like, longer than the body; thorax broader than long, about as wide as the head; hind femora powerful, well developed and adapted for leaping; hind tibiæ with a double row of long spines growing longer towards the tip; anal cerci long and tapering; ovipositor of female as long or longer than the abdomen; wing covers as long or shorter than the abdomen bent down at the sides. Wing covers of male provided with a well-developed organ for stridulation; hind wings as long, longer or shorter than the abdomen, sometimes aborted.

Gryllus pennsylvanicus *Burmeister.*

PLATE V, FIGS. 6 AND 7.

Wholly shining jet black, covered with a very fine grayish pubescence on the thorax, legs and underside of body. In older examples this pubescence becomes abraded, and the insect is then very glossy. The wing covers are as long or more or less shorter than the body, and vary in color from ochraceous brown to pitchy black. The hind wings are shorter, or as long, or extend considerably beyond the wing covers, like tail-like projections. Length, 10 to 20 mm.; ovipositor, 12 to 15 mm.

The above description includes the forms known as *Gryllus luctuosus* Serv., *G. nigra* Harris, and *G. neglectus* Scud.

G. luctuosus is the form with the hind wings projecting like tails beyond the wing covers; *G. neglectus* is the form with the wing covers as long or shorter than the abdomen in the female and as long as the abdomen in the male; *G. nigra* is the form with somewhat shorter ovipositor.

This insect is very common everywhere in this neighborhood from May until frost, in open fields and woods, under stones, sticks and rubbish. The eggs are laid singly in loose soil, and the young crickets emerge in fourteen days. The egg is elongated, whitish, and is slightly curved ; the sides almost parallel. Length, 2 mm. ; width, .75 mm. The young cricket is pitchy black with a whitish longitudinal stripe on the middle of the head ; the stripe is continuous along the back to the end of the body. The first abdominal segment is sordid white above and below. The thorax is also whitish beneath. At the end of body are two ferruginous bristle-like appendages with rather long hairs.

Gryllus abbreviatus *Serville.*

Head, thorax and body shining black. The legs vary from reddish brown to pitchy black. Wing covers fusco-testaceous, and as long or nearly as long as the abdomen. Hind wings shorter than the wing covers. The ovipositor of the female is very long. Length, 18–23 mm. ; length of ovipositor, 18–21 mm.

This species may be distinguished from the preceding species by the remarkable length of the ovipositor of the female, and by the great size of the head. It is also a much heavier and clumsy species. Quite common in this vicinity, especially in the sandy districts of Long Island and New Jersey. The insect makes its appearance during August and lasts until frost. The eggs, as far as my experiments are concerned, do not emerge before the following year. *G. angustus* Scudder is the form which is less clumsy and considerably narrower than *G. abbreviatus*.

Gryllus domesticus *Linn.*

PLATE V, FIG. 8.

Pale brown, with chestnut-brown markings on the head and thorax. The wing covers extend to the end of the abdomen, and the hind wings extend considerably beyond. Length, 21 mm.; ovipositor, 12 mm.

This is the European House-cricket, or "cricket of the hearth," whose familiar chirp is so well known in houses, and especially about fireplaces. In this vicinity it is not common.

Nemobius *Serville.*

Small sized species, allied to the genus *Gryllus*. Head and thorax with comparatively long hairs; first and second joints of maxillary palpi minute, third and fifth joints of about equal length, fourth joint smaller. The venation of the wing covers of the female differs from *Gryllus*, the veins running longitudinally, while in *Gryllus* they run obliquely from both sides, thus forming lozenge-shaped spaces between. Hind tibiæ with long spines of unequal length. Ovipositor of female straight, longer or shorter than the abdomen.

Nemobius fasciatus (*De Geer*).

PLATE V, FIG. 9.

Dusky brown to almost piceous, with head and thorax hairy; the wing covers and legs sometimes paler. On the head are four black longitudinal stripes, which are only faintly visible in dried specimens. A black line also on each side of the thorax, continuous with a line of the same color along the sides of the wing covers. Body above black, with indications of two rows of pale spots. Underside pale brown with a broken, blackish, spot-like stripe on each side. In the male the pale portion of the underside of the body is usually reduced to a stripe along the middle. The ovipositor is straight, and pointed obliquely upwards, and is about as long as the hind femora. Spines on tibiæ of hind legs rather long. The wing covers in the male are as long or almost as long as the abdomen, and in the female they are about half as long. The hind wings are over twice the length of the wing covers, and project beyond like tails. Length, male and female, about 9–11 mm.; ovipositor, 8 mm.

Nemobius fasciatus, form **vittatus** (*Harris*).

PLATE V, FIG. 10.

This form only differs from *fasciatus* in having the hind wings aborted ; in color, size and marking it is the same.

The form *vittatus* is exceedingly common in open wood and meadows in this vicinity. It is found from July until frost. The form *fasciatus* is quite scarce. The stridulation of this species is a continuous silvery, drop-like sound. It can be reproduced by taking a silver half-dollar between two fingers and striking the coin with the edge of a nickel.

Nemobius affinis *Beutenmüller.*

PLATE V, FIG. 11.

Shining ; head and thorax fusco-testaceous or wholly piceous, and sparsely covered with rather long hairs. Antennæ longer than the body. Wing covers of the female not reaching the end of the body, and with a paler line along the angle where the wing turns down at the sides. In the male the wing covers reach the tip of the abdomen. Hind wings absent. The abdomen above in both sexes is blackish, with faint traces of some paler spots ; on the underside the body is wholly testaceous, as are also the legs. Anal appendages extending beyond the ovipositor, which points obliquely upwards. Length, about 6–8 mm. ; ovipositor, 3–4 mm. ; anal appendages, 6.5 mm.

Closely allied to *Nemobius fasciatus*, form *vittatus*, but is much smaller and more shining. It also differs by the shortness of the ovipositor, it being about one-half as long, and by having the abdomen wholly testaceous beneath. The stridulation is a long, continuous, soft, rolling *whirrrrrrr*. The insect occurs from about the latter part of July until frost. It is found in the same places as the preceding species, and is rather common.

Anaxipha *Saussure.*

Closely allied to *Nemobius*, but differs by having the ovipositor of the female sabre-like and curved upwards with the end compressed. The antennæ are very long, about five times as long as the body, and the spines of hind tibiæ are of equal length. Wing cases of male almost encasing the abdomen, with a round glassy patch on top near the end of the wing. Hind wings absent.

Anaxipha exigua (*Say*).

Head and thorax testaceous with a few short hairs, and the former with three blackish lines in front, connivant at the mouth parts. Antennæ very long, about five times as long as the insect. Wing covers paler than the thorax, reaching the end of the abdomen in the male and somewhat shorter in the female. Hind wings absent. Abdomen of male black; abdomen of female pale testaceous above and below, black laterally. Ovipositor curved, chestnut brown. Length about 5 mm. Ovipositor, 2 mm. Antennæ, 20 mm.

This insect is not uncommon in this vicinity, and occurs from August until late in October. It is most common during late August and early September. It lives mostly on bushes, rarely on the ground, and especially on bushes growing in salt meadows. According to Mr. Davis it clings to the stems from six inches to a foot above the ground, and its song has a particularly silvery tone.

Phylloscirtus *Guérin*.

Small sized. Head broader than the thorax; eyes prominent and protruding. Antennæ long, hair-like; ocelli absent; last joint of maxillary palpi exceedingly broad, spoon-like; last joint of labial palpi similar but very much smaller; thorax longer than broad; abdomen almost entirely encased by the wing covers; hind wing present or wanting; wing covers of female with parallel longitudinal veins; ovipositor sabre-like, short, and curved upwards; sides of wing cases of male bent obliquely downwards; hind legs graceful, with weak spines on the tibiæ.

The species of this genus somewhat resemble small Cicindelas, and may be at once recognized by the very broad spoon-like joints of the palpi.

Phylloscirtus pulchellus (*Uhler*).

Plate V, Fig. 16.

Head and thorax bright crimson red, the latter with the lateral margins narrowly bordered with white; palpi black; antennæ much longer than the body, black at base, then whitish for some distance, then again blackish to the tip. Abdomen shining jet black; wing covers chestnut brown or almost black. Legs yellowish. Length, 7 mm.

Rather scarce in this vicinity. It is found on shrubs and limbs of trees, during September and October.

Apithus agitator *Uhler.*

It is possible that this insect may be found in the vicinity of New York City. It is a southern species, and may be looked for in southern New Jersey. It inhabits grape vines and dense shrubbery, and is found fully developed in September.

Orocharis saltator *Uhler.*

Like the preceding, this is also a southern species, and possibly may occur here. It also inhabits shrubbery and trees.

Œcanthus *Serville.*

Thorax elongated, narrow, sides deflexed, anterior portion somewhat narrower than the posterior portion. Antennæ about twice as long as the body. Hind legs long and slender, with weak spines on the tibiæ. Wings of female wrapped around the body. Wing covers of male flattened and transparent.

The members of this genus may be easily known by their narrow and slender hind legs and structure of the wings.

Œcanthus niveus (*De Geer*).

PLATE V, FIGS. 12 AND 13.

Wholly pale, whitish green with two slightly elevated black dots on the underside of each antenna, one on the first and one on the second joint. Top of head and first joint of antennæ usually pale yellowish brown. Tip of ovipositor of the female black. Wing covers almost twice as long as the abdomen ; hind wings as long as the upper. Average length, from head to tip of wings, 16 mm.; body, 11 mm. ; width of male wing covers, 6 mm. ; female, 3 mm.

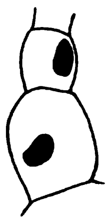

FIG. 2. Underside of basal joints of antennæ of *Œ. niveus.*

Very abundant during August and September in gardens and open woods, on vines and trees. The stridulation of this insect is very shrill and only heard at night, but sometimes also on cloudy days and in dark places in the shrubbery, when the song is quite faint.

The stridulation is a continuous, pulsating, equally sustained *trrr-reee-trrr-reee*, etc. ; it has also been described as a pulsating sound like *re-teat*, *re-teat*, or *a-beat*, *a-beat.*

Œcanthus angustipennis *Fitch.*

Wholly pale greenish white; wings transparent and sometimes with a pale yellowish-brown patch on top of the head. Antennæ with two elevated black marks on the underside, the one on the first joint hooked at the base, with the hook turned inward and the mark on the second joint oblong. Average length from head to tip of wing covers, 14 mm.; body, 10 mm.; width, 3.5 mm.

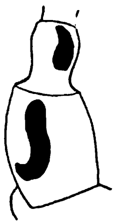

FIG. 3. Underside of basal joints of antennæ of *Œ. angustipennis.*

This species is not as common as *Œ. niveus.* It inhabits the higher parts of different kinds of forest and fruit trees. The stridulation is very different from *Œ. niveus.* It is a faint, continuous *reeeeeeé*, lasting about five seconds, and terminating abruptly, with an equal interval of rest. Usually sings at night only, but sometimes also late in the afternoon in shady places, and on cloudy days. The insect may be readily separated from *niveus* by the much narrower wing covers and the different shaped marks on the basal joint of the antennæ. Found from August until the colder weather sets in.

Œcanthus nigricornis *Walker.*

Yellowish green, with three more or less distinct black, longitudinal stripes on the head and thorax, which are sometimes entirely black. The legs are yellowish with a blackish tinge, or entirely black. Underside of body black; upperside yellowish green. Antennæ black with four black marks on the first two joints. The innermost mark on the first joint about twice the length of the outer, and nearly always confluent at the upper ends. On the second joints the marks are more equal. In many individuals the antennæ are entirely black; then the marks are not discernible. Hind wings extending more or less beyond the wing covers. Average length from head to tip of wing covers, 15 mm.; body, 11 mm.; width, male, 4.5 mm., female, 3 mm.

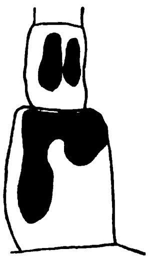

FIG. 4. Underside of basal joints of antennæ of *Œ. nigricornis.*

Our most common species in this vicinity. It is found from the latter part of July until frost, along roadsides and in open fields on low bushes. The stridulation is a very shrill, continuous *whirrr*, often lasting several minutes. It sings in the hottest sunshine and by night.

Œcanthus 4-punctatus *Beutenmüller.*

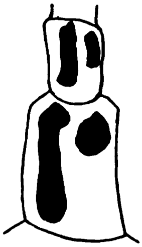

FIG. 5. Underside of basal joints of antennæ of *Œ. 4-punctatus.*

Wholly pale yellowish green, with the antennæ fuscous; basal joints yellowish green with two black marks on the underside of each of the first and second joints. The marks are similar to those of *Œ. nigricornis*, but are not united on the first joint as is usually the case in *nigricornis*. The wings protrude more or less beyond the wing covers. Size about the same as *Œ. nigricornis.*

Found in the same localities with *Œ. nigricornis*, and it is possible that it may be a form of that species.

Œcanthus pini *Beutenmüller.*

Head and antennæ testaceous, the latter becoming darker towards the tip; first two joints with four black marks; the inner mark on the first joint long and straight, the outer oblique; those on the second joint parallel; eyes black; thorax testaceous with a longitudinal line on each side above; anterior pairs of legs testaceous; posterior femora green, tibiæ testaceous; body beneath black with the sides yellowish green; body above blackish with a green stripe along the back; elytra transparent, with grass-green veins; hind wing slightly protruding beyond the elytra; veins also green.

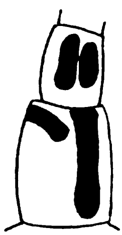

FIG. 6. Underside of basal joints of antennæ of *Œ. pini.*

The female is somewhat paler than the male, and the wings extend a little more beyond the elytra; ovipositor dark testaceous, tip black. Average length from head to tip of wing covers, 14 mm.; body, 12 mm.; width, 4.5 mm.

Somewhat resembles *Œ. nigricornis*, but may be readily distinguished from it by the grass-green color of the wings and the testaceous head and thorax, and marks on basal joints of the antennæ. This insect lives only on pine trees, and usually on the high branches. Its song is a continuous, soft and metallic *reeeeeeeeee*, with numerous undulations. When many individuals are heard together, their stridulations sound not unlike the jingling of sleigh-bells at a distance.

Has been found by me in Windham Co., Conn., and it is not unlikely that the insect also occurs in this vicinity. It should be looked for in the pine districts.

Œcanthus latipennis *Riley.*

Pale yellowish green, with the wing covers very much broader in the male than in any other species of the genus. The antennæ are destitute of black marks on the underside of the first two joints, which are characteristic of the other species of *Œcanthus*. The basal joints of the antennæ and top of head are of a distinct pink color. The wing covers extend considerably beyond the abdomen, and the wings in the male are much shorter than the wing covers, and in the female about as long. Average length from head to tip of wing covers of male 16 to 19 mm.; width of wing covers, 7–8 mm.; female, 14–17 mm.; width, 3–4 mm.

Quite scarce in this vicinity, but not uncommon in certain localities on Staten Island. The insect lives on low plants, in damp places. The stridulation is a shallow, continuous trill lasting for some time, with indefinite intervals of rest. Sings late in the afternoon and by night. Found during September and October. Easily distinguished from the other species by the pink color of the basal joints of the antennæ and top of head.

Xabea *Walker.*

Body smooth, shining, slender; head broader than the thorax; antennæ with a rather short tubercle on the underside of the basal joint; first and second joints of the maxillary palpi cylindrical, minute; third joint very long and slender; fourth joint much smaller than the second, clavate; fifth joint longer than the third, straight on one side and swollen on the other, apex oblique; thorax long, sides parallel; wing almost twice as long as the wing covers; legs pubescent; hind tibiæ without spines. In form and general appearance this genus very much resembles *Œcanthus*, but differs in having the hind tibiæ unarmed, different palpi, and long hind wings.

Xabea bipunctatus (*De Geer*).

PLATE V, FIG. 14.

Pale pinkish brown, with two rather large blackish spots on each of the upper wings in the female. The hind wings very long and extend much beyond the upper wings, and have a decided opalescent hue when expanded. The legs are pale with a pinkish hue. In the male the dark spots on the upper wings are absent. Length to tip of wing covers about 17 mm.; body about 13 mm.; width about 5 mm.; female, 4 mm.

Easily recognized by its pinkish-brown color and the dark spots on the wing cases in the female.

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Synopsis of Species of Gryllidæ.

Tridactylus.

Antennæ shorter than body, anterior tibiæ flattened and armed with teeth.
Small species: glossy black, sometimes marked with red... *T. terminalis.*

Gryllotalpa.

Antennæ shorter than body; anterior tibiæ flat, armed with teeth and a movable, claw-like organ outside.
Large species: brown, covered with short hairs.
Wing covers less than half the length of abdomen: wings extending a little beyond wing covers............... *G. borealis.*
Wing covers more than half the length of abdomen; hind wings very long.................................... *G. columbia.*

Gryllus.

Antennæ longer than the body; wing covers abruptly bent down at sides.
Black, wing covers sometimes brown; ovipositor, 12–15 mm. long.
Hind wings short; wing covers as long as the abdomen, *G. pennsylvanicus.*
Hind wings extending beyond the wing covers, like tails, form *luctuosus.*
Wing covers shorter than the abdomen in the female, hind wings abbreviated .... form *neglectus.*
Ovipositor rather short............................form *nigra.*
Wing covers always testaceous.
Form robust; hind femora usually ferrugineous; ovipositor, 18–21 mm. long.................................*G. abbreviatus.*
Much more slender than *abbreviatus*.......... form *angustus.*
Pale testaceous, head and thorax with chestnut-brown markings, *G. domesticus.*

Nemobius.

Small species, allied to *Gryllus*; with rather long hairs; hind tibiæ with unequal spines.
Underside of abdomen with a testaceous stripe along the middle; ovipositor very long.
Hind wings extending beyond the wing covers like tails, *N. fasciatus.*
Hind wing aborted.................................. form *vittatus.*
Underside wholly testaceous beneath; ovipositor short. ....*N. affinis.*

Anaxipha.

Small size; antennæ exceedingly long; spines of hind tibiæ equal in length; ovipositor sabre-like.
Wholly pale testaceous; abdomen black beneath..............*A. exigua.*

Phylloscirtus.

Head broader than thorax; last joints of palpi enlarged, spoon-like.
Head and thorax crimson red........................*P. pulchellus.*

Œcanthus.

Hind leg slender, tibiæ with weak spines.
Antennæ with one black mark on the two basal joints:
Wing covers broad; marks on antennæ in shape of small dots, *Œ. niveus.*
Wing covers narrow; mark on first joint of antennæ long and hooked at base; mark on second joint oblong, *Œ. angustipennis.*
Antennæ with two black marks on the first two basal joints:
Head, thorax, legs and antennæ usually black; marks on first joint of antennæ generally connected at apex....*Œ. nigricornis.*

Wholly pale greenish white, transluscent; marks on antennæ elongate, parallel, distinct .... *Œ. 4-punctatus.*
Head, thorax and legs testaceous; hind femora, veins of wings grass-green; inner marks on first joints of antennæ straight, the outer oblique; on second joint, parallel.......... *Œ. pini.*
Antennæ without marks on underside of first two joints.
Wing covers very broad; head and basal joints of antennæ pink .... *Œ. latipennis.*

Xabea.

Hind legs slender, tibiæ without spines.
Pinkish brown; first joint of antennæ tuberculate beneath, *X. bipunctatus.*

LOCUSTIDÆ.—Grasshoppers.

The species of this family, found in this vicinity, are divided into five subfamilies, which may be separated by the following characters:

Prosternum without spines.
Wing covers broad; hind wings longer than wing covers; vertex not elongated into a cone or tubercle.......... Phaneropterinæ.
Prosternum with long slender spines.
Wing covers and wings very broad; concave .... Pseudophyllinæ.
Wing covers narrow, tapering towards the apex, shorter than the hind wings; head with a blunt tubercle or prominent cone, Conocephalinæ.
Wings and wing covers rudimentary.
Pronotum extending over the first abdominal segment; prosternum with spines.......... Decticidinæ.
Wings and wing covers absent.
Pronotum not extending over the first abdominal segment; prosternum without spines.......... Stenopelmatinæ.

PHANEROPTERINÆ.

Scudderia *Stål.*

Head oval; eyes round and protruding, vertex pinched; antennæ longer than the wings, first joint cylindrical, stout; second joint smaller, remaining joints hair-like. Thorax longer than broad, narrower in front than behind; lateral carina sharply defined. Wing covers shorter than the wings and nearly of equal width throughout, apex rounded. Hind legs very long and slender. Male with the anal plates provided with two curved spines, the one from the supra-anal plate curved downward and notched at the end, and the one from the subanal curving upwards and grooved above. Female with the ovipositor short, broad, flat and turned upwards, with the apical portion very finely serrate.

The species of this genus may be known by their narrow wing covers and the singular anal processes of the male.

Scudderia curvicauda (*De Geer*).

PLATE VII, FIGS. 5 AND 6.

Wing covers, legs and thorax pale grass green ; head and underside of body paler ; pronotum much longer than broad, narrower in front than behind, and with a yellow line along the lateral carina. The notch of the supra-anal spine is square, with a minute median tooth, the lateral parts of the notch compressed.

Measurements.—Length of body, 22–25 mm. ; wing covers, 33–37 ; posterior femora, 25–27 mm.

Common everywhere in this vicinity from August until late in the fall. The insect may be found clinging to tall grasses, weeds and low bushes in meadows, especially in damp places.

Scudderia furculata *Brunner*.

Very much resembles the preceding species, but may be separated from it by the notch of the supra-anal spine of the male being acute and the sides of notch rounded, flattened at the end and compressed beneath into a small flat process. The female is very difficult to separate, but lacks the black color at the basal fold of the ovipositor.

Measurements.—Male : Length of body, 20–23 mm. ; wing covers, 34–38 mm. ; posterior femora, 24–30 mm. Female : Length of body, 22 mm. ; wing covers, 34 mm. ; posterior femora, 27 mm.

Found in the same localities as *S. curvicauda*, from August until late in fall. Not common.

Scudderia furcata *Brunner*.

Grass green ; wing cover narrow and of equal width throughout, apex rounded ; lateral carina of pronotum without trace of a yellow line. The notch of the supra-anal spine of the male is very deep, and the lateral pieces very much swollen.

Measurements.—Male : Length of body, 16 mm. ; wing covers, 31 mm. ; posterior femora, 23 mm. ; pronotum, 5 mm. ; width of wing covers, 6 mm. Female : Length of body, 20 mm. ; wing covers, 30 mm. ; posterior femora, 22 mm. ; ovipositor, 5 mm.

Very common from early in August until late in fall. Found on low bushes and grasses, especially in damp meadows and roadsides.

Scudderia angustifolia (*Harris*).

Very closely allied to the preceding species, but somewhat smaller, and has the hind femora shorter, and the wing covers narrower; there is also a distinct yellow line along the lateral carina of the pronotum. In color it is the same as *S. furcata*.

Measurements.—Male: Length of body, 14–15 mm.; wing covers, 25–26 mm.; pronotum, 4 mm.; posterior femora, 19–20 mm. Female: Length of body, 19–21 mm.; wing covers, 25 mm.; ovipositor, 5.5 mm.

Common in the same localities as the preceding species. August until late in fall.

Scudderia fasciata *Beutenmüller*.

Head green, with a white line on the face, and at the sides a yellowish mark; basal joint of antennæ green, following joints dark testaceous, becoming darker towards the apex; pronotum dark grass green, paler at the sides, and a rather broad yellow stripe along the lateral carina; wing covers dark grass green with a pale yellowish brown shade along the inner (dorsal) margin, preceded by a blackish line running from the base of the wing to the apex; another blackish line runs along the costal vein; hind wings transparent, veins green and a dark green apical patch shaded with blackish; sides of abdomen green, above purplish; underside with a white and purplish stripe on each side, and green along the middle; tip of anal spines of the male and ovipositor of female reddish brown; anterior legs green, femora testaceous at the base; middle legs entirely green; hind legs green, with the femora marked with black outside; tibiæ with black spines; tarsi of all the legs purplish brown.

Measurements.—Male: Length of body, 18 mm.; pronotum, 4 mm.; posterior femora, 18 mm.; wing covers, 25 mm.; expanse, 61 mm. Female: Length of body, 21 mm.; pronotum, 4 mm.; posterior femora, 17 mm.; wing covers, 21–23 mm.; expanse, 50 mm.

This species occurs on pine trees, and in color very much assimilates to the leaves of this tree. It has been found in Connecticut and near Ithaca, N. Y.

Scudderia pistillata *Brunner*.

Apex of vertex concave; pronotum narrower in front than behind; wing covers very broad, wider at the middle than at the base and apex, with radiating veins; anterior margin curved, inner margin quite straight, apex rounded; supra-anal process notched at the apex, with short, rounded lobes; subanal process extending a little beyond the upper process.

Measurements.—Male: Length of body, 16–20 mm.; wing covers, 29–31 mm.; posterior femora, 21–23 mm. Female: Length of body, 18–20 mm.; wing covers, 27–30 mm.; posterior femora, 21–23 mm.

This species may be easily recognized by the broad wing covers. It is found in the same localities as *S. curvicauda*, but is rare. August and September.

Scudderia truncata *Beutenmüller.*

Somewhat resembles *S. pistillata*, but is much smaller, the wings are narrower and almost of equal width, with the anterior margin curved and the inner margin somewhat concave, apex rounded; eyes protruding and larger than those of *S. pistillata*; pronotum narrower in front than behind, somewhat concave; supra-anal plate of male with no elongated spine, but is abruptly pointed with the apex truncate and minutely notched. The subanal process is long and slender, suddenly turned upwards, and much less curved than that of *S. pistillata.*

Measurements.—Male: Length of body, 15 mm.; wing covers, 26 mm.; posterior femora, 19 mm.

Very rare in this neighborhood. Taken at Vineland, N. J.

Amblycorypha *Stål.*

Head with the vertex flat; eyes elliptical or oblong oval; antennæ thread-like, first joint large and thick, second joint but slightly smaller, third joint slender. Wing covers broad and rounded at the tip. Male with the supra-anal plate truncate; subanal plate short and broad at base, narrower at apex, with a deep triangular notch, each tip with a short blunt spine-like process. Female with a long, flat, curved ovipositor, deeply serrated towards the end.

Easily recognized by the broad oblong rounded wing covers.

Amblycorypha rotundifolia (*Scudder*).

PLATE VI, FIG. 2.

Wing covers oblong oval, pale pea-green, body somewhat paler; hind wings transparent, with the veins and apical patch green; posterior femora with four or five small spines and reaching to the tip of the wing covers; ovipositor of female strongly curved upwards and strongly serrated at the apical portion.

Measurements.—Length of body, about 20 mm.; wing covers, 27 mm.; posterior femora, 23 mm.

Common in this vicinity from the latter part of July until late in September. It inhabits thickets, or is found on bushes and shrubbery in open places.

Amblycorypha oblongifolia (*De Geer*).

Allied to *A. rotundifolia*, but is longer and broader. The wing covers extend beyond the posterior femora, and the anterior portion of the thorax is considerably narrower than the posterior. Color pale pea-green, sometimes wholly rose color. Lower carina of posterior femora with about ten strong teeth.

Measurements.—Length of body, 21 mm.; wing covers, about 38 mm.; posterior femora, 30 mm. Expanse of wings, 75 to 85 mm.

Rather common in this neighborhood during August and September until frost. Found in similar places with the preceding species. Instead of being green, this insect is sometimes entirely rose colored.

Microcentrum *Scudder*.

Larger and stouter than *Amblycorypha*. Vertex of head with a transverse furrow; eyes oval, prominent; pronotum a little longer than broad, anterior portion slightly narrower, lateral carina sharp. Wing covers broad, and gradually sloping from the middle towards the apex, which is rounded and quite pointed, thus making the outer portion of the wing covers, beyond the middle, somewhat triangular. Hind femora about half as long as the wing covers. Supra-anal plate triangular. Subanal plate of male forked at the tip, similar to that of *Amblycorypha*. Ovipositor of female quite short, broad and abruptly curved upwards, blunt at the tip.

Microcentrum laurifolium (*Linn.*).

PLATE VI, FIG. 3.

Wing covers grass green, with the venation conspicuously marked, extreme anterior edge light brown; hind wings transparent, with green veins; body light green or clay colored.

Measurements.—Length of body, 28 mm.; pronotum, 6 mm.; wing covers, 46 mm.; posterior femora, 26 mm.; width of wing covers, 14 mm.; pronotum, 5.5 mm.; expanse of wings, 95 mm.

Quite rare in this vicinity, but more common in the Southern States. It may be easily recognized by its large size and leaf-like resemblance of the wing covers, especially when the wings are closed. It may also be known by its short posterior femora and tibiæ, which in the two preceding species are much longer. The eggs are gray, oval and very flat, and laid on the edge of a leaf in single or double chain-like rows, the edges of the eggs overlapping one another.

PSEUDOPHYLLINÆ.

Cyrtophyllus *Burmeister.*

Head large and stout; eyes hemispherical and comparatively small; vertex spine-like; antennæ almost twice as long as the wings; pronotum as broad as long on top with two transverse furrows; lateral carina well rounded, lobes of sides parallel, with angles acutely rounded; wings concave; wing covers longer than the hind wings, a little more than twice as long as broad, and of almost equal width, with the apex obtusely rounded. Anterior pairs of legs long and rather stout, and well adapted for climbing; hind legs almost twice the length and also stout. Supra-anal plate longer than broad, and bluntly rounded at the tip; subanal plate of male very long, paddle-shaped, and grooved on the upper side; ovipositor of female quite long and curved upwards beyond the middle.

Cyrtophyllus concavus (*Harris*).

PLATE VI, FIG. 1.

Wing covers and thorax bright green; head, legs and body much paler; hind wings transparent. When the insect is at rest the wing covers curve around the body, so that their edges touch above and beneath; pronotum roughly punctured and somewhat wrinkled; head smooth.

Measurements.—Length of body, 30–35 mm.; wing covers, 33–36 mm.; posterior femora, 19–21 mm.

This is the well-known Katydid. It may be readily known by its robust form and broad, concave wings. The insect is arboreal in habit, living on the branches in the dense foliage of the tops of trees. Common in this neighborhood during August and September until the colder weather.

CONOCEPHALINÆ.

Conocephalus *Serville.*

Head with the vertex more or less prolonged forward and upward into a cone, with a pointed tooth beneath; face very oblique; pronotum flat, narrower in front than behind; lateral carina quite sharp, lobes of side curving obliquely backwards in front and well rounded behind. Wing covers narrow, broader at the base than the apex. Hind wings long and quite narrow. Cerci of male swollen, curved inwards and toothed. Ovipositor of female very long and straight.

The species of this genus are readily known by having the vertex prolonged into a cone-like process, and by the narrow wings.

Conocephalus robustus *Scudder.*

Plate VI, Fig. 9.

Wholly bright green or pale brown, with the wing covers sometimes sparsely speckled with black. Cone of vertex pronounced and obtusely rounded at the apex, entirely green or with a slight touch of black at the apex, beneath; the tooth before the middle small and blunt; pronotum with a yellow stripe along the lateral carina and running along the head to the apex of the cone. Wing covers extending considerably beyond the posterior femora, quite broad at base in the male, with the singing apparatus well developed. The wing covers of the female are narrower, and the ovipositor somewhat longer than the posterior femora. Hind wings of both sexes almost as long as the wing covers.

Measurements.—Male: Length of body, 30 mm.; wing covers, 46 mm.; posterior femora, 24 mm.; expanse, 96 mm. Female: Length of body, 35 mm.; wing covers, 48 mm.; posterior femora, 25 mm.; ovipositor, 26 mm.; expanse, 96 mm.

This insect is very common in this vicinity, especially in the salt meadows of Long Island, Staten Island and New Jersey, amongst the tall grasses and rushes. Its song is exceedingly loud and shrill, and can be heard at a considerable distance; when the insect is near the sound is quite deafening. It is a continuous *bzzzzzzzz*, increasing and decreasing in volume. It somewhat resembles the song of the Harvest-fly (*Cicada canicularis*). August and September.

Conocephalus exiliscanorus *Davis.*

Plate VII, Figs. 1 and 2.

Very much resembles *C. robustus*, but may be distinguished from it by the very long, sharp cone on the head, which projects upwards; the underside of the cone is shining black from the sharp-pointed tooth near the base to the apex. The wings are shorter than in *C. robustus*, but are equally as broad. The ovipositor of the female is much longer than the posterior femora, while in *C. robustus* it is about as long. The tooth on the underside of the cone of the head is also sharper and more prominent, and the head is longer and broader.

Measurements.—Male: Length of body, 34 mm.; wing covers, 39 mm.; posterior femora, 23 mm.; expanse, 85 mm. Female: Length of body, 40 mm.; wing covers, 43 mm.; posterior femora, 23 mm.; ovipositor, 38 mm.; expanse, 92 mm.

Found from the latter part of July until cold weather in the salt marshes and meadows of Staten Island. Its song is very different from that of *C. robustus*, instead of the loud, shrill buzz, it is much slower, being a continuous shrill *a-zip—a-zip—a-zip*, or *zit-zit-zit*, etc. Sings late in the afternoon and at night.

Conocephalus ensiger *Harris.*

PLATE VI, FIG. 8.

Much smaller and more graceful than the two preceding species. The cone on the head is similar to that of *robustus*, but has a black line on each side beneath, running from about the middle of the apex.

Measurements.—Male: Length of body, 26–28 mm.; wing covers, 38–40 mm.; posterior femora, 18–20 mm. Female about the same size; ovipositor, 25 mm.

Rather common from about the middle of July until October in damp fields amongst the tall grasses and weeds. It is also found in salt meadows. Its stridulation is very different from that of the other species of *Conocephalus*, being a continuous *ik-ik-ik-ik-ik-ik*, etc. Sings late in the afternoon and by night.

Conocephalus dissimilis *Serville.*

PLATE VII, FIGS. 3 AND 4.

Similar in shape to *C. ensiger*, but the cone is much shorter, broader, obtusely rounded at the apex, and not pointed and elongated as in *C. ensiger*. The wings and wing covers are also shorter.

Measurements.—Length of body, 23-28 mm.; posterior femora, 17-20 mm.; wing covers, 28-34 mm.; ovipositor of female, 34 mm.

Found during August and September in the same localities as the preceding species.

Orchelimum *Serville.*

Size small; face oblique; vertex with a blunt tubercle at the apex, and meeting a smaller and similar projection from beneath; antennæ very long, thread-like; first joint very stout and cylindrical; second joint considerably smaller; pronotum flat on top, lateral carina well rounded, lobes of sides almost parallel, then forming more or less of a triangle at the bottom. Wing cases of the male narrow, broad to about the middle, then suddenly but gradually narrowing; stridulating organ well developed. In the female the wing cases are of almost equal width ; cerci with a sharp tooth-like hook inside, directed inward ; ovipositor of female slightly curved, and terminating in a sharp point ; anterior pairs of tibiæ with a number of spines.

Orchelimum vulgare *Harris.*

PLATE VI, FIGS. 4 AND 5.

Shining, grass green, with a broad, more or less distinct stripe on the head and thorax and back of abdomen. The legs are testaceous or partly green. Antennæ twice as long as the body, testaceous. Wings extending beyond the tip of the abdomen.

Measurements.—Male: Length of body, 17–21 mm. ; Wing covers, 18–22 mm. ; posterior femora, 14–15 mm. Female: Length of body, 17–21 mm. ; wing covers, 15–20 mm. ; posterior femora, 15–17 mm.

Very abundant in this vicinity from about the middle of July until late in autumn. It is found in open fields, copses and along ditches, usually resting on leaves and stems of bushes and tall grasses. Dr. Scudder says : " When about to sing on a hot sunny day, the male mounts a stalk of grass about a foot from the ground, where it clings with its four front legs, allowing its hind legs to dangle on either side the stalk, that they may not interfere with the wing covers. Beginning with a *ts* it changes almost instantly into a trill of *zr*. At first there is a crescendo movement which reaches its volume in half a second ; the trill is then sustained for a period varying from one to twenty seconds, but generally from six to eight seconds, and closes abruptly with *p*. This strain is followed by a series of very short staccato notes sounding like *jip*, *jip*, *jip*, repeated at half-second intervals ; the staccato notes and trill alternate *ad libitum*. The staccato notes may be continued almost indefinitely, but are very rarely heard more than ten times in direct succession ; it ordinarily occurs three or four times before the repetition of the phrase, but not more than two or three times when the phrase is not repeated."

Orchelimum concinnum *Scudder.*

Green, with a broad, dark reddish brown longitudinal band along the middle of the thorax and head where the stripe narrows to the width of the tubercle on the vertex of the head, passing over this down the front to the mouth, expanding broadly in the middle of the face ; legs green or brownish green. Wing cover greenish brown, shorter than the hind wing in the male, and as long or nearly so in the female; hind wings transparent, with dark veins; ovipositor of female slightly curved.

Measurements.—Length of body, 18 mm.; wing covers, 20 mm.; hind femora, 16 mm.; ovipositor, 8 mm.; expanse, 44 mm.

Quite rare in this vicinity. It frequents damp and marshy localities and lowlands. Found from July to late in the fall. It may be readily separated from *O. vulgare* by its being a much more slender and graceful insect with narrower wing covers.

Orchelimum agile (*De Geer*).

Recorded from New Jersey and southward. Possibly will also be found in this vicinity.

Xiphidium *Serville.*

Very closely allied to the genus *Orchelimum*, from which it can hardly be separated. The species, however, are much smaller and more graceful, and the ovipositor of the female is straight instead of curved. Wings as long, longer, or shorter than the abdomen.

Xiphidium fasciatum (*De Geer*).

PLATE VI, FIG. 7.

Pale green, with a broad reddish brown longitudinal band on its thorax, running to the top of the head, where it is considerably narrower; face entirely green; abdomen above reddish, green beneath. Wing covers and wings extending much beyond the body, reaching the tip of the ovipositor in the female. Hind wings somewhat longer than the wing covers.

Measurements.—Length of body, 13.5 mm.; wing covers, 17 mm.; hind femora, 11 mm.; ovipositor, 8 mm.

Common everywhere, in swampy meadows, from the latter part of June until late in the fall.

Xiphidium brevipennis *Scudder.*

PLATE VI, FIG. 6.

Smaller and somewhat stouter than *X. fasciatum*. Color light green or pale brown, with the band on the thorax and head the same as in *fasciatum*. Wings almost as long as the body, and not extending beyond as in *fasciatum*. The ovipositor is also longer. Antennæ about three times as long as the body.

Measurements.—Length of body, 9–12 mm.; wing covers, 6–8 mm.; posterior femora, 11–12 mm.; ovipositor, 9–12 mm.

Very common in damp fields overgrown with tall grass and weeds, but especially abundant in salt meadows. Found from the latter part of July until late in autumn.

Xiphidium nemorale *Scudder.*

Greenish brown; wing covers greenish with the front margin blackish, nearly as long as the abdomen in the male, somewhat shorter in the female; top of head and pronotum with a broad, very faint, reddish longitudinal stripe margined with a whitish line on each side; legs greenish with many red dots; wing covers with prominent cross-veins; ovipositor of female as long as the abdomen, slightly curved upwards apically.

Measurements.—Male: Length of body, 14 mm.; wing covers, 8 mm.; hind femora, 12 mm. Female: Length of body, 15 mm.; wing covers, 5.5 mm.; hind femora, 13 mm.; ovipositor, 9 mm.

This species may be found from about the middle of August until frost, resting on low shrubs and weeds along roadsides and the borders of dry upland woods. It is a western insect, and in this vicinity it occurs in New Jersey along the eastern slope of the Palisades.

Xiphidium nigripleurum *Bruner.*

Reported from Ithaca, N. Y., and may possibly be taken in this vicinity.

DECTICIDINÆ.

Atlanticus *Scudder.*

Head rounded; vertex compressed; pronotum flattened on top with the lateral carina sharp and abruptly bent down at the sides. The pronotum is narrower in front than behind, and slightly pinched before the middle; it also extends backwards over the first abdominal segment. Wing covers of female rudimentary and hidden under the pronotum; those of the male about half as long as the body; ovipositor of female stout at base, straight, flattened, and pointed obliquely upwards.

Atlanticus pachymerus (*Burmeister*).

PLATE VII, FIG. 7.

Grayish brown, with the wing covers of the male marked with black. The abdomen and femora are sprinkled with minute blackish dots. The extreme lateral edge of the pronotum with a yellowish border, preceded by a black streak at the posterior portion.

Measurements.—Male : Length of body, 20 mm. ; pronotum, 9 mm. ; wing covers, 8 mm.; posterior femora, 15 mm. Female somewhat larger ; ovipositor, 20 mm.

Rare in this vicinity. It occurs in dry places, especially along hill sides. Found from about the middle of June until late in September.

Atlanticus dorsalis (*Burmeister*).

PLATE VII, FIG. 8.

Closely allied to the preceding species, but may be distinguished from it by being larger, and the legs and ovipositor considerably longer. The color is much the same as in *A. pachymerus*.

Measurements.—Length of body, 24 mm. ; pronotum, 10 mm.; posterior femora, 25 mm.; ovipositor, 30 mm.

Found in similar localities as the preceding species. Very rare.

STENOPELMATINÆ.

Ceuthophilus *Scudder*.

Wingless ; head large, oval, vertex not tuberculate ; last joint of palpi longer than the third, and grooved beneath at the apex ; antennæ very long, usually two or more times as long as the body ; pronotum not extending over the meta- and mesothorax as in *Atlanticus*, and well rounded on top ; abdomen arched ; legs long, slender, with a few spines ; hind femora swollen at the base, channelled beneath, and more or less spined ; hind tibia with more than four pairs of spurs, first tarsal joint almost as long as the rest together ; ovipositor of female straight, more or less swollen at the base.

The members of this genus live in dark, damp places in cavities, under stones, mole hills, and in cellars.

Ceuthophilus gracilipes *Scudder*.

Ground color of body varying from luteous to dark castaneous, very heavily marked with black, so that the latter is often or perhaps generally the prevailing tint; the dark colors prevail always on the hinder half of all the segments. The black markings are irregular and much broken; outer sides of the posterior femora with blackish transverse streaks, more or less distinct. Antennæ about three to four times as long as the body. Legs very long. Hind femora as long or longer than the body, stout at base and about twice the length of the fore femora; outer carina of the hind femora of the male with about thirteen coarse spines; inner carina with the spines considerably shorter and more even; in the female the carina are almost unarmed; hind tibiæ longer than the femora, straight or slightly waved.

Measurements.—Male: Length of body, 19–22 mm.; antennæ about 75 mm.; pronotum, 5.75 mm.; fore femora, 10 mm.; hind femora, 20 mm.; hind tibiæ, 24.75 mm. Female slightly larger; ovipositor, 15.5 mm.

Found during July and August in dark cellars of houses and barns, in hollow places under stones, and in hollow trees. It is one of the largest of the species of *Ceuthophilus* found in this vicinity.

Ceuthophilus grandis *Scudder.*

PLATE V, FIG. 17.

Allied to the preceding species; in color and markings it is almost the same, but differs from it in having the pronotum and legs somewhat longer; the hind femora are also longer and more robust.

Measurements.—Male: Length of body, 19 mm.; pronotum, 6.5 mm.; antennæ, 90 mm.; fore femora, 11 mm.; hind femora, 22 mm.; hind tibia, 25 mm. Female somewhat larger; ovipositor, 13.5 mm.

This insect has been taken at West Farms, New York City; heretofore it was only known from Tennessee. It is closely related to *C. gracilipes*, but is a heavier insect and the spines on the hind femora of the male are longer.

Ceuthophilus uhleri *Scudder.*

Reddish brown or rufo-testaceous, heavily flecked with dark fuscous so as to produce a tolerably uniform mottled appearance; on the pronotum is a pale medio-dorsal streak; the flecking is made up of small more or less confluent dots; legs luteous more or less infuscated, especially the apical portion of the femora and the markings of the hind femora; antennæ about twice as long as the body; fore femora less than half as long as the hind femora, about one-third longer than the pronotum, and about one-fourth longer in the female; hind femora stout, about three and a third times as long as broad, with the outer portion of the apical half and upper portion of the inner side with scabrous raised points, the outer carina armed with 7–8 unequal inequidistant coarse irregular spines, or almost unarmed but for some 3–4 raised points in the female, the inner carina with about 16 small spines or only a few slight ones on the apical fourth in the female ; hind tibiæ longer than the femora.

Measurements.—Male : Length of body, 15 mm.; pronotum, 5 mm.; hind femora, 17.75 mm.; hind tibiæ, 18.5 mm.; fore femora, 7.35 mm. Female : Length of body, 15 mm.; pronotum, 4.6 mm.; hind femora, 13 mm.; hind tibiæ, 18.5 mm.; fore femora, 5.75 mm. ; ovipositor, 8.25 mm.

Rather scarce, living under stones.

Ceuthophilus neglectus *Scudder.*

Castaneous, more or less infuscated, especially above sides luteous; a broad more or less and often very obscure mediodorsal rufo-luteous stripe on the pronotum, sometimes extended farther back but then generally broken ; the side of the pronotum and to a lesser extent the meso- and metathorax are more or less blotched with luteous, and the abdomen is more or less but generally feebly maculated with luteous ; the legs are generally luteo-castaneous, the tips of all the femora dark, sometimes almost black, the hind femora with scalariform fuscous markings ; antennæ two to three times as long as the body ; the legs are rather slender and moderately short ; fore femora much less than half as long as the hind femora and but little longer than the pronotum ; hind femora stout, the upper and lower margins almost equally arcuate, almost three times as long as broad, the inner surface with a few raised points next or at the upper margin beyond the middle, scarcely visible or absent in the female ; both carina minutely, closely and uniformly serrulate, through all but the basal third, the inner carina a feebler repetition of the outer. In the female the serrulations are sometimes almost imperceptible ; hind tibæ scarcely as long or not longer than the femora. Ovipositor half as long as the hind tibiæ.

Measurements.—Male : Length of body, 12.5 mm.; pronotum, 4.4 mm.; fore femora, 5 mm.; hind femora, 12 mm.; hind tibiæ, 12 mm. Female about the same size ; ovipositor, 6 mm.

This is one of the smallest species of *Ceuthophilus* found in this vicinity. It is not common.

Ceuthophilus maculatus (*Harris*).

Glabrous, mottled with luteous and blackish, the darker markings predominating ; on the pronotum a luteous, mediodorsal stripe, also traces of such a stripe along the dorsum of the meta- and mesothorax ; the hind femora are strongly infuscated outside and inside ; the anterior pairs of femora infuscated at the apex and all the tibiæ at the base; posterior tibiæ infuscated along the upper side; fore femora a little more than a fourth longer than the pronotum, and much less than half as long as the hind femora; hind femora as long as the body, three and a half times as long as broad, moderately stout at base, and with no raised points on the upper or inner surface, outer carina with about thirteen unequal coarse spines in the male, and minute distant inconspicuous spinules in the female; inner carina with similar but uniform spines, none so large as on the outer carina (male) or with a few minute spinules on the apical half (female), the intervening sulcus not very broad. Hind tibiæ feebly undulate in the basal half in the male. Ovipositor nearly two-thirds as long as the hind femora.

Measurements.—Male: Length of body, 14 mm.; pronotum, 5 mm.; fore femora, 6.6 mm.; hind femora, 15.25 mm.; hind tibiæ, 16.25 mm. Female slightly larger; ovipositor, 10 mm.

Found in woods under stones, in hollow trees and under loose bark.

Ceuthophilus terrestris *Scudder.*

Recorded from northern New York, the New England States and Maryland, and will doubtless also be found in this vicinity.

Ceuthophilus lapidicolus (*Burmeister*).

Recorded from Pennsylvania and southward; may be found in this vicinity.

Ceuthophilus blatchleyi *Scudder.*

Recorded from New York, and possibly will also be found in this neighborhood. It is closely allied to *C. uhleri*, but differs by having slightly different and weaker armature of the carina of the hind femora, by the slenderer hind femora, and the narrower inferior sulcus of the same.

Ceuthophilus latens *Scudder.*

Recorded from Ithaca and Endfield Falls, N. Y., and southwestward to Texas. It will possibly be found also in this vicinity.

Synopsis of Species of Locustidæ.

Scudderia.

Wing covers long and narrow, grass green.
  Anal segment of male with one decurved spine above and one recurved spine below; ovipositor curved upwards.
    Notch of supra-anal spine square, with a minute median tooth; sides of notch slender and compressed at tip...... *S. curvicauda.*
    Notch of supra-anal spine acute; sides of notch rounded, lower margin thinner.............................. *S. furculata.*
  Notch of supra-anal spine very deep and rounded, with the sides much swollen, forming a thick, fork-like process.
    Grass green; length of hind femora, 19–20 mm...... *S. angustifolia.*
    Grass green; length of hind femora, 22–23 mm......... *S. furcata.*
    Wing covers with black streaks; hind femora 17–18 mm., *S. fasciata.*
Wing covers broad; stridulating organ large; pronotum almost as broad as long on top.
  Supra-anal spine of male similar to that of *furculata*, but not compressed at the apex.............................. *S. pistillata.*
  Supra-anal plate of male truncate, spine absent.............. *S. truncata.*

Amblycorypha.

Wing covers oblong broad, somewhat expanded in the middle and well rounded at the apex.
  Supra-anal plate truncate; subanal plate furcate, with two short spines; ovipositor of female long, recurved.
    Hind femora reaching the tip of the wing covers.... *A. rotundifolia.*
    Hind femora shorter, not reaching the tip of the wing covers, *A. oblongifolia.*

Microcentrum.

Wing covers broad in the middle, tapering suddenly towards the apex; ovipositor very short, recurved.
  Hind femora short, about half as long as the wing covers, *M. laurifolium.*

Cyrtophyllus.

Wing covers very broad and concave.
  Legs stout; subanal plate of male elongated, paddle-like; ovipositor of female recurved, long.............................. *C. concavus.*

Conocephalus.

Head with a cone-like projection; wing covers narrow; ovipositor very long and straight.
  Cone of head long, bluntly pointed, with a slight touch of black at the apex.............................. *C. robustus.*
  Cone of head very long, rather sharply pointed, black beneath to about the middle.............................. *C. exiliscanorus.*
  Smaller species: Cone of head pointed, bordered beneath with black from about the middle to the apex.............................. *C. ensiger.*
  Cone of head broad, not pointed, obtusely rounded at apex.. *C. dissimilis.*

Orchelimum.

Pronotum with lateral carina rounded; vertex with blunt tubercle; ovipositor slightly curved.
  With broad brown stripe on top of head and pronotum........ *O. vulgare.*
  With broad stripe on face, top of head and pronotum...... *O. concinnum.*

Xiphidium.

Small species, more slender and graceful than *Orchelimum*; ovipositor straight.

Wings and wing covers extending beyond the abdomen.
Green ; with a broad reddish brown stripe on top of the head and pronotum . . . . *X. fasciatum.*
Wings and wing covers shorter than the abdomen.
Green ; with a broad reddish brown stripe on the top of head and pronotum . . . . *X. brevipennis.*
Greenish brown, stripe on head indistinct, margined by two white lines ; legs with small red dots . . . . *X. nemorale.*

Atlanticus.

Pronotum extending over the first abdominal segment ; male with short wing covers, female wingless.
Legs long ; hind femora 27 mm. ; ovipositor 30 mm. long. . . . . *A. dorsalis.*
Legs shorter; hind femora 22 mm. ; ovipositor 20 mm. long, *A. pachymerus.*

Ceuthophilus.

Body stout ; arcuate above, wingless.
Large size : Legs very long ; fore femora of male from one-half to two-thirds as long again as the pronotum.
Hind femora of male much less than four times as long as broad ; hind tibiæ very long, sometimes sinuous at base, *C. gracilipes.*
Hind femora of male much more than four times as long as broad ; hind tibiæ scarcely longer than the hind femora, *C. grandis.*
Medium size : Legs shorter ; fore femora but little longer, if any, than the pronotum ; hind tibia waved.
Hind femora of male three and a half times as long as broad ; no large spines on the outer carina . . . . *C. maculatus.*
Small species : fore femora a little longer than the pronotum.
Hind femora stout ; outer carina of male with minute spines, *C. neglectus.*

ACRIDIDÆ.—Locusts.

The members of this family found in this vicinity are divided into four sub-families, which may be characterized as follows :

Prosternum smooth or with an indistinct tubercle ; hind angle of pronotum truncate or nearly so.
Head more or less pyramidal, face oblique, antennæ flattened, TRUXALINÆ.
Prosternum entirely smooth.
Hind margin of pronotum acute-angled . . . . ŒDIPODINÆ.
Prosternum with a long tubercle.
Hind margin of pronotum obtusely angled . . . . ACRIDIDINÆ.
Pronotum extending back over the abdomen to its extremity or beyond it ; very small species.
Wing covers rudimentary . . . . TETTIGINÆ.

TRUXALINÆ.

Truxalis *Linnæus.*

Head slightly ascending on top ; vertex projecting, horizontal and rounded in front. Face very oblique, with the median carina sulcate, lateral carina straight, more or less distinct, reaching the corners of the face; eyes oblong, oblique, and placed well forward; antennæ about as long as the head, flattened at the base and rounded towards the tip; pronotum twice as long as broad, sides perpendicular, flat and almost parallel; top of pronotum flat with lateral and median carina, and three indistinct transverse incisions; wing covers long and narrow, obliquely truncate at apex; prosternum smooth; all the wings extend somewhat beyond the posterior femora, which are flattened and longer than the tibiæ. The male is similar to the female, but is very much smaller.

Truxalis brevicornis *Linnæus.*

PLATE VIII, FIGS. 1 AND 2.

Pale green, somewhat dotted with brown over the wing covers; lateral carina of pronotum and antennæ and edge of vertex brown; mouth parts and front legs pinkish brown. Hind wings transparent, with the veins greenish. The male is usually entirely pinkish brown, with the fore wings much paler along the inner margin. Some individuals have the top of head, face, the two front pairs of legs and the inner margin of the fore wings green. Hind wings dusky, greenish at the base.

Measurements.—Male: Length of body, 19–21 mm.; wing covers, 19–20 mm.; posterior femora, 12–13 mm.; expanse, 39–43 mm. Female: Length of body, 35 mm.; wing covers, 31 mm.; posterior femora, 20 mm.; expanse, 63 mm.

Rare in this neighborhood. It is found during August and in early September in damp or swampy places overgrown with grass and weeds. The insect is local in habit.

Opomala *Serville.*

Head pyramidal, and very large in the female, and much longer than the pronotum, face very oblique, antennæ flattened, enlarged at the base; top of head with a distinct median carina in the female and less distinct in the male; prosternum with a minute tubercle; pronotum twice as long as wide, sides perpendicular, top parallel truncate in front and behind, carina somewhat indistinct; wing covers lanceolate, reaching a little beyond the middle of the abdomen in the male, shorter in the female; hind wings abbreviated; hind legs slender, femora reaching the tip of the abdomen. The male is considerably smaller and more graceful than the female.

Opomala brachyptera *Scudder.*

Light brown, sometimes streaked with dark brown; knees of hind legs black; wing covers much shorter than the abdomen.

Measurements.—Male: Length of body, 23 mm.; wing covers, 10 mm.; posterior femora, 12 mm. Female: Length of body, 28 mm.; wing covers, 8 mm.; posterior femora, 12 mm.

Very rare in this vicinity. Found during July. In general appearance the female of this insect very much resembles the pupa of *Truxalis brevicornis.*

Syrbula admirabilis (*Uhler*).

This species was described from Maryland, and has also been recorded from New Jersey, but at present we have no knowledge of its occurrence in this vicinity.

Chloëaltis *Harris.*

Female: Top of head rounded, vertex produced into a short, blunt pyramid; face oblique, with the median carina broad, slightly sulcate, and a rather sharp lateral carina; eyes large, extended forward, and pointed at the apex; pronotum parallel with three carina; sides perpendicular, compressed; wing covers half as long as the abdomen; hind wings somewhat shorter. The wings in the var. *punctulata* are as long as the abdomen. The male is much smaller, with the face more oblique, and the wings nearly reaching the tip of the abdomen.

Chloëaltis viridis *Scudder.*

PLATE VII, FIG. 10.

Female grass green or dirty brown, with a blackish line beginning behind the eye and running along the lateral carina of the pronotum. Hind tibiæ brown. The male is green on top of the head and pronotum, upper half of wing cases and middle pair of legs; face pale yellowish brown, remaining parts dirty brown. Hind wings smoky in both sexes.

Measurements.—Male: Length of body, 16 mm.; wing cases, 8 mm.; posterior femora, 10 mm. Female: Length of body, 25 mm.; wing covers, 9 mm.; posterior femora, 14 mm.

Very common from the latter part of July until late in the fall, in dry grassy fields, meadows and hillsides.

Chloëaltis viridis var. punctulata *Scudder.*

Differs from the preceding by having the wings extending to the tip of the abdomen. Wing covers green and marked with scattered, small blackish-brown spots. Hind wings smoky and about as long as the wing covers.

Found in the same localities as *C. viridis*, but is quite rare in this vicinity.

Chloëaltis conspersa *Harris.*

PLATE VII, FIG. 9, MALE.

Wholly dirty brown with minute darker brown dots, except the underside of abdomen orange yellow and the posterior tibiæ red; hind femora with one or two rather large light brown patches outside. Wings about half as long as the abdomen. The male is much narrower than the female; the wing covers are broad and extend nearly to the tip of the abdomen; hind wing very small; the antennæ are considerably longer than those of the female. In color it is yellowish brown; sides of pronotum glossy black, as are also the first few abdominal segments; hind femora with two light-colored spots outside; hind tibiæ red, black at base and apex.

Measurements.—Male: Length of body, 20 mm.; wing covers, 10 mm.; posterior femora, 13 mm. Female: Length of body, 23 mm.; wing covers, 7 mm.; posterior femora, 13 mm.

Found in dry grassy places on hillsides, fields, and in open woods, during the latter part of July until October. Not common. It may be easily recognized by the light-colored spots on the outside of the posterior femora, and red hind tibiæ.

Stenobothrus *Fischer.*

Body elongate, rather narrow. Face oblique with the carina as in *Chloëaltis*, as also the vertex. Pronotum more or less constricted about the middle, with the three carina usually distinct; wing covers narrow, as long, longer or shorter than the abdomen.

This genus is closely allied to *Chloëaltis*, but may be distinguished from it by the constricted pronotum, and the narrower and more elongate body.

Stenobothrus maculipennis *Scudder.*

PLATE VIII, FIG. 4.

FIG. 7. Head of *S. maculipennis.* (Female.)

Head and pronotum green or brown, or pinkish brown with black markings; on each side of the pronotum is a velvety-black stripe, broken in the middle by the lateral carina, which are whitish or pinkish. Wing covers narrow, and extending beyond the abdomen, green or brown with a row of square spots along the middle and scattered over the outer portion; hind wings almost as long as the wing covers. Legs green or brown, hind femora sometimes with a reddish tinge.

Measurements.—Female: Length of body about 20 mm.; wing covers, 18 mm.; posterior femora, 12 mm.; pronotum, 3 mm. Male: Length of body, 16 mm.; wing covers, 14 mm.; posterior femora, 9 mm.; pronotum, 2.5 mm.

Common in dry grassy places, especially on sandy soil. Found during July until October. It is somewhat variable in color, some individuals being wholly green or brown, or any mixture of the two, but green males are the least common of any of the forms. Some specimens show considerable rose-red, or may be very largely blackish fuscous throughout.

Stenobothrus olivaceus *Morse.*

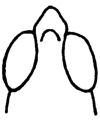
FIG. 8. Head of *S. olivaceus.* (Male.)

Closely allied to *S. maculipennis*, but differs in having the vertex more nearly horizontal, more acute, more angulate with the front in profile; more narrowed between the eyes. The face is more oblique; the antennæ are shorter, more flattened toward the base and more finely pointed. The pronotum is longer and less constricted, thus making the space between the lateral carina broader, and the carina in straight lines rather than curves. In color it varies from brown to olivaceous. Size same as that of *S. maculipennis.*

Has been taken at Stamford and Greenwich, Conn.; also at Sandy Hook, N. J. It is found during August and September in salt marshes near the seashore. It will probably also be found on Long Island and at other places in this vicinity.

Stenobothrus æqualis *Scudder.*


FIG. 9. Head of *S. æqualis.* (Female.)

Resembles *S. maculipennis* and *S. olivaceus*, from which it may be distinguished by the shorter and blunt vertex; the disk of the anterior portion of the pronotum is broader and the wing covers only extend to the tip of the abdomen. It is also somewhat smaller. The variety *bilineatus* has two broad black bands running from behind the eyes, inside the lateral carina, to the end of the pronotum.

Common everywhere in this vicinity in dry places covered with short, stubby grass. It is also variously colored, being either green or brown, or both. The males are rarely green.

Stenobothrus curtipennis (*Harris*).

Head and thorax pale yellowish brown, olive gray or dirty grass green; wing covers light or dark yellowish brown; underside of body bright yellow; legs yellowish ; hind femora black at apex ; hind tibia black at the knee, rest pale reddish or yellow ; behind the eyes is a shining black stripe, which extends to the end of the pronotum ; this stripe is usually more or less distinct, but sometimes almost absent ; antennæ black-brown at the base, sometimes wholly black ; wing covers shorter than the abdomen. In the variety *longipennis* the wings are as long or longer than the abdomen.

Measurements.—Male : Length of body, about 15 mm.; wing covers, 9–15 mm.; posterior femora, 11 mm.; antennæ, 10 mm. Female : Length of body, 20–25 mm. ; wing covers, 9–15 mm. ; posterior femora, 13 mm. ; antennæ, 7 mm.

Found from the latter part of July until October, in swampy meadows. Rather common.

ŒDIPODINÆ.

Chortophaga *Saussure.*

Body compressed ; legs remote ; antennæ somewhat flattened, short ; pronotum acutely angled behind, median carina elevated into a keel-shaped ridge ; sides almost parallel.

Chortophaga viridifasciata (*De Geer*).

PLATE VIII, FIG. 9.

Head and thorax bright green ; abdomen yellowish green ; hind femora green with black bands inside ; hind tarsi lead color with a white band near the base ; wing covers wholly green or green along the costal margin to beyond the middle with the remaining part semi-transparent, dusky ; hind wings transparent, yellowish green at base, smoky towards the outer portion ; antennæ reddish.

Measurements.—Male : Length of body, 21 mm. ; wing covers, 20 mm. ; hind femora, 12 mm. Female : Length of body, 25 mm.; wing covers, 22 mm.; hind femora, 14 mm.

Chortophaga viridifasciata var. infuscata (*Harris*).

In this variety the head, thorax and wing covers are dusky brown, the latter with a few darker patches. The hind femora are pale brown and whitish inside with black bands. The hind wings and hind tarsi are the same color as in the preceding form. Size also the same.

Found everywhere in this vicinity in open pastures from the latter part of April until frost. Double brooded. The variety *infuscata* is less abundant, but more common in the South.

Encoptolophus *Scudder.*

Head somewhat swollen, cheeks and face rounded, the latter with the median carina sulcate, lateral carina distinct ; vertex broad, somewhat concave, triangular in front ; pronotum pinched at the sides ; median carina elevated, distinct, and cut in the middle by a distinct notch ; lateral carina indistinct ; hind angle triangular ; wing covers of equal width except at the base ; hind wings broad and almost as long as the wing covers ; both reaching a little beyond the abdomen ; hind femora rather flat and broad.

Encoptolophus sordidus (*Burmeister*).

PLATE X, FIG. 2.

Dusky brown, varied with lighter and darker shades ; pronotum with a pinkish buff X-shaped mark on top ; hind femora with blackish and buff-colored bands ; hind tibiæ blackish with a sordid white band near the base ; wing covers fuscous, semitransparent, with two distinct pale transverse fasciæ, and other small pale spots scattered over the wings ; hind wings transparent, yellowish at base and the outer portion smoky.

Measurements.—Male : Length of body, about 19 mm. ; wing covers, 19 mm. ; hind femora, 13 mm. Female : Length of body, 28 mm. ; wing covers, 24 mm. ; hind femora, 15 mm.

Common everywhere in this neighborhood in pastures and gardens. It occurs during the months of September and October.

Camnula pellucida *Scudder.*

Occurs in Connecticut and northward, and probably also may be found in this vicinity.

Arphia *Stål.*

Head large ; pronotum keel-shaped, arcuate, granulated, notched or entire, and more or less angled behind ; lateral carina wanting ; wing covers long and narrow ; hind wings broad ; hind femora compressed and dilated.

Arphia sulphurea (*Fabricius*).

PLATE VIII, FIG. 10.

Vertex of head triangular in front ; pronotum obtusely angled in front and behind ; median carina prominent, slightly curved ; head, thorax, wing covers, abdomen and legs dark brown ; hind femora outside also dark brown, inside black with white bands ; hind tarsi black, or sometimes blackish lead color, with a white band near the base ; hind wings yellow on basal half, outer part blackish, with dash of the same color below the costa, running for some distance in the yellow color.

Measurements.—Male : Length of body, 20 mm. ; wing covers, 21 mm.; hind femora, 13 mm. Female : Length of body, 30 mm. ; wing covers, 24 mm.; hind femora, 15 mm.

Found from about the middle of May until the middle of July in dry, open grassy places.

Arphia xanthoptera (*Burmeister*).

PLATE VIII, FIG. 11.

Closely allied to *A. sulphurea*, but is a larger and heavier insect. The pronotum is acute in front and very acutely pointed behind ; the median carina is keel-shaped and arched. In color and markings it is similar to the preceding species.

Measurements.—Male : Length of body, 24 mm.; wing covers, 25 mm.; posterior femora, 15 mm. Female : Length of body, 32 mm.; wing covers, 29 mm.; posterior femora, 18 mm.

Occurs in similar localities as *A. sulphurea*, but especially on dry sandy places and hillsides. Found during the latter part of August and until the latter part of September.

Hippiscus *Saussure.*

Form robust ; pronotum granulate, median carina distinct and slightly notched before the middle ; sides of pronotum somewhat compressed in the middle and above on each side of the carina ; truncate in front and acute angled behind, vertex flattened and continuous with the median carina of the face ; wings extending beyond the abdomen.

Hippiscus tuberculatus (*Pal. de Beauv.*).

PLATE X, FIG. 3.

Ashy lead color, darker above, abdomen beneath yellowish brown ; antennæ ochreous at base, piceous toward the apex ; head uniform in color ; pronotum with a dark brown streak along the middle of the lateral lobes ; posterior edge of pronotum ochreous ; wing covers like the body in color, with fuscous blotches and with the axillary fold yellowish brown ; hind wings coral red at the base, with an arcuate blackish band and the apex nearly transparent ; hind femora ashen brown with two blackish dashes more or less distinct, inside black or prussian blue at base, then ochreous with a black or blue band ; hind tibiæ ochre yellow.

Measurements.—Male: Length of body, 25–30 mm.; wing covers, 25–30 mm.; hind femora, 15–17 mm. Female: Length of body, 40 mm.; wing covers, 33 mm.; hind femora, 21 mm.

This species makes its appearance early in May and is found until July. It occurs in dry pastures or open fields covered with a growth of low bushes.

Hippiscus phœnicopterus (*Germar*).

PLATE IX, FIG. 4.

Head ashen gray with darker shades; pronotum grayish brown tinged with olive green, with a more or less distinct angular band on each side; abdomen pale ochre yellow; wing covers marked with large black spots, apex semitransparent with the spots smaller; hind wings at base deep orange red, outside of this and just beyond the middle the wings are crossed by a curved black band, running from the costa to the anal angle, apex transparent; hind femora yellowish brown with three indistinct bands, inside deep blue and with a yellow ring near the apex; hind tibiæ yellowish, tinged with orange in some specimens.

Measurements.—Male: Length of body, 30 mm.; wing covers, 30 mm.; posterior femora, 17 mm. Female: Length of body, 43 mm.; wing covers, 39 mm.; posterior femora, 21 mm.

Very rare in this vicinity, but more common in the Southern States. It is found during June and July in dry pastures and waste places.

Hippiscus rugosus (*Scudder*).

Recorded from the New England States, and may possibly also be found in this vicinity. The basal portion of the hind wings are yellow instead of red, as in the two preceding species.

Dissosteira *Scudder*.

Size large; head prominent; median carina of the pronotum high, compressed and notched near the middle, arched on the posterior lobe and almost straight on the anterior lobes; wings and wing covers extending about one-third their length beyond the abdomen.

Dissosteira carolina (*Linnæus*).

PLATE X, FIG. 6.

Varies in color from almost sepia brown to rusty brown, with small dusky dots; wing covers more or less covered with spots; hind wings black with a pale yellow outer border, dusky at the apex with a few black spots ; hind femora whitish inside, black at base to about the middle, apex black and a black band between ; hind tibia dirty white with a more or less distinct black and white annulus at the base.

Measurements.—Male : Length of body, 27 mm. ; wing covers, 30 mm. ; posterior femora, 14 mm. Female : Length of body, 35–37 mm.; wing covers, 40 mm.; posterior femora, 18 mm.

This is one of the most common Grasshoppers we have in this vicinity. It is found everywhere, in open fields, meadows and dusty roads, and often seen in the city streets. It is distributed from the Atlantic to the Pacific coasts.

Trimerotropis *Stål.*

Vertex continuous with the median sulcus of the face ; body covered with very short hairs ; pronotum compressed before the middle, narrower in front than behind ; slightly angled in front and acutely angled behind ; median carina slight and broken by two wide notches before the middle ; lateral carina distinct on the posterior lobe and broken on the anterior lobes ; wing covers long and narrow ; hind wings narrowing to a point at the apex.

Trimerotropis maritima (*Harris*).

PLATE X, FIG. 5.

Head, pronotum, legs and posterior femora white, sprinkled with minute atoms and dots of black and brown; eyes ochraceous; inside of hind femora with two black spots ; hind tibiæ light yellow, spines tipped with black ; wing covers also whitish, sprinkled more or less with black and brown atoms and spots, apex transparent ; hind wings at base semi-transparent, pale yellow followed by an arcuate, narrow black band, more or less broken by the veins, outer third of wing transparent.

Measurements.—Male : Length of body, 23 mm. ; wing covers, 24 mm. ; posterior femora, 13 mm. Female : Length of body, 32 mm. ; wing covers, 33 mm. ; posterior femora, 16 mm.

Very common on the seashores of Long Island, Staten Island and New Jersey. The insect may be readily known by its white color. Found from the latter part of July until about the middle of September.

Spharagemon *Scudder.*

Body pubescent ; top of head somewhat swollen ; vertex broad, tapering rapidly, and continuous with the median sulcus of the face ; pronotum compressed before the middle, disk somewhat flattened ; more or less acutely angled behind ; median carina compressed, more or less keel-shaped, and divided by a deep furrow, the front portion being a little shorter ; lateral carina almost obsolete. Wings extending beyond the tip of the abdomen ; wing covers almost of equal width throughout ; hind wings subtriangular.

Spharagemon bollii *Scudder.*

PLATE X, FIG. I.

Brownish fuscous, somewhat variable in color ; face grayish, with minute blackish dots ; hind femora grayish or brown, pale dirty yellow inside with black bands, which are indistinct outside ; hind tibiæ coral red, black at base, and followed by a dirty white and black band occupying almost half the tibiæ ; wing covers earthen-brown with many darker minute spots, and three more or less distinct blackish brown transverse fasciæ ; hind wings pale yellow at base, with a median, arcuate black band ; outer portion of the wing transparent, sometimes dusky at the apex, especially in the male.

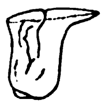

FIG. 10.

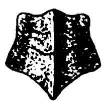

FIG. 11.

Side and top of pronotum of *S. bollii.*

Measurements.—Male : Length of body, 20–22 mm. ; wing covers, 22–25 mm.; posterior femora, 12.5–13.5 mm. Female : Length of body, 27–33 mm.; wing covers, 23–28 mm.; posterior femora, 12.5–17 mm.

This species is found on dry sandy soil, in pastures, near the edges of woods, and on almost any ground of barren character. It is of local distribution, and occurs from the latter part of July until late in October.

Spharagemon saxatile *Morse.*

Pronotum stout, slightly compressed anteriorly, broad posteriorly ; front margin of disk slightly angulated, hind margin right angled, the apex blunt ; median carina low, severed before the middle by a vertical incision, the anterior portion of the carina being higher than the posterior half. Body stout and less compressed than in *S. bollii ;* blackish fuscous in spots and bands on an ash-gray ground color, abdomen somewhat yellowish ; pronotum with an ash-gray X-shaped mark on the disk ; hind femora ash gray and sprinkled with black outside, yellowish inside with four transverse black bands, which are less

FIG. 12.

FIG. 13.

Side and top of pronotum of *S. saxatile.*

distinct outside ; hind tibiæ coral red, black at base, followed by a whitish annulus ; wing covers ashen gray sprinkled with black and with three rather broad blackish bands ; hind wings sulphur yellow at base, followed by an arcuate median black band ; apical third of wings transparent, apex more (male) or less (female) fuscous.

Measurements.—Male : Length of body, 20–24 mm.; wing covers, 21.5–25.5 mm.; posterior femora, 11–14 mm. Female : Length of body, 32–39 mm.; wing covers, 25–31 mm.; posterior femora, 14–17 mm.

This species has been taken at Greenwich and New Haven, Connecticut, and at New Foundland, New Jersey. The insect is found in unsettled, somewhat wooded districts of a rocky, often elevated character. The color of the insect so harmonizes with the tints of the lichen-covered rocks that it is quite difficult to distinguish it when at rest. It is allied to *S. bollii* and *æquale*, but differs in shape of the median carina and hind angles of the pronotum. In color it very much resembles *Circotettix verruculatus*, which is found in similar haunts.

Spharagemon æquale (*Say*).

PLATE IX, FIG. 5.

Pronotum with median carina high and strongly compressed on the posterior lobe with a deep oblique incision, the dorsal edge of the carina arched on both lobes ; front margin of pronotum angulate, hind margin acute, sharp pointed, and excavate at the sides ; head, thorax and wing covers light rusty brown, granulated and spotted with lighter brown flecks ; hind femora with four transverse bands more or less distinct ; disk of pronotum sometimes with a paler indistinct X-shaped mark ; hind tibiæ coral red sprinkled with fuscous at the base, and sometimes with indications of a pale annulus near the base ; hind wings pale yellow at base, followed by a black arcuate band reaching the anal angle.

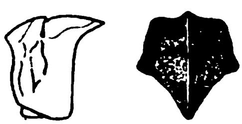

FIG. 14. FIG. 15.
Side and top of pronotum of *S. æquale.*

Measurements.—Male : Length of body, 21–23 mm.; wing covers, 23–24.5 mm.; posterior femora, 13–14 mm. Female : Length of body, 27–29 mm.; wing covers, 25.5–28.5 mm.; posterior femora, 14–16.5 mm.

This species may be found in open fields, on sandy soil, from about the middle of July until October. Very rare and local in this vicinity, but not rare, locally, in the sandy districts of Staten Island, New Jersey and Connecticut.

Circotettix *Scudder.*

Eyes somewhat prominent; vertex channelled, and continuous with the median sulcus of the face; head somewhat broader than the anterior lobes of the pronotum; posterior lobe of pronotum broader and acute angled behind; median carina slightly elevated, with two rather deep notches before the middle; lateral carina indistinct on the posterior lobe, but not prominent. Wings and wing covers longer than the body; the latter are of equal width throughout, with the apex oblique; the former are rather broad.

Circotettix verruculatus (*Kirby*).

PLATE IX, FIG. 6.

Ash gray, heavily mottled with black and gray; sometimes the black almost obscuring the entire head, thorax and wing cases, thus giving the insect a very black appearance; abdomen black; hind femora with four more or less distinct black bands; hind tibiæ yellowish with a black band at the base, a broader one at the extremity and one before the middle; hind wings semitransparent, light yellow at the base and followed by a narrow, black, arcuate band; apex transparent tipped with black; sometimes the transparent space is black, but of a lighter shade than the band.

Measurements.—Male: Length of body, 22 mm.; wing covers, 24 mm.; posterior femora, 11 mm. Female: Length of body, 30 mm.; wing covers, 28 mm.; posterior femora, 13 mm.

This is a mountain insect, and it mimics the dark gray rocks covered with lichens. The nearest locality for the occurrence of the insect in this vicinity, as far as we are aware, is Delaware Water Gap, but it is not unlikely that it will also be found in the mountainous districts of New Jersey, nearer by. August and September. It is common in the mountains of New York, in New England, and westward. When flying, it produces a clicking noise.

Psinidia *Stål.*

Head large; antennæ flattened; pronotum granulated, acute angled behind, very much compressed before the middle; median carina distinct with two notches; lateral carina distinct on posterior lobe, broken on the anterior lobes; wing covers narrow, hind wings broad, both extending beyond the body.

Psinidia fenestralis (*Serville*).

PLATE VIII, FIG. 3.

Ash colored, variegated with gray and dark brown ; body beneath yellowish buff ; hind femora grayish outside, black at base inside, a band beyond the middle and black at the apex, these bands are repeated outside ; hind tibiæ whitish, with a black ring at each end, and one of the same color before the middle ; wing covers ashen gray, variegated with brown and black, transparent at the apex ; hind wings pinkish red, salmon color or pale orange yellow at the base, then a rather broad arcuate smoky black band ; apex transparent in the female, more or less tipped with black in the male, the dark color usually connecting with the black band and enclosing a transparent patch.

Measurements.—Male: Length of body, 15 mm.; wing covers, 19 mm.; posterior femora, 10 mm. Female: Length of body about 25 mm.; wing covers, 23 mm.; posterior femora, 13 mm.

Common near the sea beaches of Long Island, Staten Island, New Jersey and Connecticut, from the latter part of July until October.

Scirtettica *Bruner*.

Allied to the genus *Psinidia*, but differs in having the pronotum less elevated and with a single notch in the middle ; the pronotum is also less acute angled behind. The hind wings are broader and more rounded.

Scirtettica marmorata (*Harris*).

PLATE X, FIG. 4.

Head and pronotum ashen gray, mottled more or less with darker markings, the pronotum sometimes with a pale, more or less distinct X-shaped mark on the disc ; hind femora gray with three black bands ; yellowish inside with the bands repeated ; hind tibiæ coral red with a blackish ring at the base, and followed by a whitish, and an indistinct black ring ; wing covers marbled with ashen gray and dark brown blotches, transparent at apex ; hind wings sulphur yellow at base, followed by a black arcuate band, apex transparent, tipped with black.

Measurements.—Male : Length of body, 15 mm. ; wing covers, 17 mm. ; posterior femora, 10 mm. Female : Length of body, 25 mm. ; wing covers, 22 mm. ; posterior femora, 12 mm.

Found in the same localities as *Psinidia fenestralis*, and also in open places in the pine districts of New Jersey, but is less common. August and September.

ACRIDIDINÆ.

Acridium *Burmeister*.

Large size; vertex concave; median carina of pronotum distinct; lateral carina rounded; prosternum provided with a long, stout, blunt spine; wings well developed, as long or longer than the body. Last segment of male not swollen.

Acridium alutaceum *Harris*.

PLATE IX, FIG. 2.

Dirty olive brown or green, with a rather broad, bright yellow longitudinal stripe on the top of the head and pronotum; wing covers brown, sometimes marked with darker dots; along the inner margin is a bright yellow stripe which becomes lost near the apex; hind wings transparent, yellowish at the base and becoming brownish towards the apex.

Measurements.—Male: Length of body, 28–32 mm.; wing covers, 25–27 mm.; hind femora, 16–20 mm. Female: Length of body, 48 mm.; wing covers, 39 mm.; hind femora, 24 mm.

Occurs in places covered with low bushes, especially *Myrica cerifera* and Sweet Fern, on which the insect usually rests. Common locally along the borders of marshy places. August and September.

Acridium rubiginosum *Harris*.

PLATE IX, FIG. 1.

Head and thorax leathery or rusty brown; wing covers of the same color, sometimes sprinkled with small, darker colored spots; hind wings transparent; yellowish at base and brownish towards the apex.

Size of preceding species, from which it differs by its redder color and by the absence of the yellow stripe on the head, pronotum and wing covers. It also inhabits similar places.

Acridium americanum *Drury*.

PLATE IX, FIG. 3.

Head with piceous and flesh-colored stripes; top of head with a broad yellowish longitudinal stripe running from the vertex to the end of the pronotum; pronotum pitchy brown with three yellow stripes on each side; abdomen pale yellow; wing covers semitransparent with a yellow stripe along the inner margin; remaining part thickly covered with large and distinct, dark semitransparent brown spots; costal margin at base yellow; wings transparent, yellowish; posterior femora buff inside and below, outside white with oblique transverse stripes meeting at the black stripe which runs along the middle; hind tarsi bright red, spines white, tipped with black.

Measurements.—Male: Length of body, about 43 mm.; wing covers, 45 mm.; posterior femora, 24 mm. Female: Length of body, 52 mm.; wing covers, 54 mm.; posterior femora, 28 mm.

Found from early in May until early in July, and again during the latter part of September until early in November. The flight of this insect is rapid and long; it often flies up into trees to escape capture. Quite rare in this vicinity, but common in the Southern States. It is the largest Grasshopper found in this vicinity.

Paroxya *Scudder.*

Body straight, subcylindrical; head rather larger; eyes prominent; antennæ longer in the male than in the female; pronotum twice as long as broad, median carina slight, lateral carina rounded, posterior lobe punctured; wings and wing covers of the male slightly shorter than the abdomen, in the female much shorter; hind femora reaching the tip of the abdomen; prosternum with a prominent subcylindrical spine.

Paroxya atlantica *Scudder.*

PLATE VIII, FIG. 5.

Top of head, pronotum and wing covers light or dark olive brown; face and sides of head bright yellow; behind the eyes commences a broad black band which also runs along the sides of the pronotum; lower part of pronotum bright yellow; abdomen yellow; anterior legs olivaceous; posterior femora outside olivaceous, inside yellow, black at apex; hind tibiæ lead-colored.

Measurements.—Male: Length of body, 23 mm.; wing covers, 13 mm.; posterior femora, 12 mm.; antennæ, 13 mm. Female: Length of body, 33 mm.; wing covers, 24 mm.; posterior femora, 17 mm.; antennæ, 10 mm.

Found in swampy places from July until early in October.

Paroxya floridana *Thomas.*

Recorded from New Jersey, and possibly will be found in this neighborhood.

Melanoplus *Stål.*

Head rounded on top; vertex continuous with the median sulcus of the face, with the portion between the eyes channelled; face with the lateral carina sharply defined; eyes prominent, nearly straight in front and rounded behind; antennæ slender, extending to the tip of the pronotum in the female, and beyond in the male; pronotum with a distinct median carina, the lateral carina obtuse and the transverse incisions more or less distinct. Wing covers long and narrow, as long, longer or shorter than the abdomen; hind wings somewhat shorter than the wing covers; first joint of hind tarsi as long as the last joint; pulvilli between the claws large; last joint of abdomen of the male much swollen.

Melanoplus femur-rubrum (*De Geer*).

PLATE VIII, FIG. 7.

Yellowish green, with a black patch behind the eyes and at the sides of the pronotum. Sides of thorax with an oblique yellow line; underside of abdomen and thorax bright yellow; hind femora yellowish green, shaded with black; hind tibiæ and tarsi coral red; wing covers olivaceous or fuscous, sometimes with a row of blackish spots along the middle; hind wings pellucid; cerci of male broad at base and pointed at the tip.

Measurements.—Male: Length of body, 20 mm.; wing covers, 18 mm.; posterior femora, 12 mm. Female: Length of body, 25 mm.; wing covers, 20 mm.; posterior femora, 15 mm.

Exceedingly common everywhere, from about the latter part of July until frost. It is sometimes very destructive to field crops, gardens, shrubs and young trees.

Melanoplus atlanis (*Riley*).

Very closely related to *M. femur-rubrum*, but may be separated by the following characters: The cerci of the male are broad, equal, and rounded at the tip and about twice as broad as long; tip of last abdominal segment notched. In the female the median carina on the anterior lobe of the pronotum is wholly wanting or very indistinct. In size and color like *M. femur-rubrum.*

Rather common in fields, from August until frost.

Melanoplus collinus (*Scudder*).

Head gray, pronotum grayish brown with a shining black patch on each side; hind femora beneath and inside yellow; outside grayish brown with three black bands encircling about half the femora above; hind tarsi red; wing covers reaching the tip of the abdomen. Cerci of male forked at the apex.

Measurements.—Male: Length of body, 19 mm.; wing covers, 13 mm.; posterior femora, 11 mm. Female: Length of body, 22–25 mm.; wing covers, 15 mm.; posterior femora, 12–14 mm.

Not uncommon during August and September in dry grassy fields. It may be easily known by the distinct black bands on the hind femora, its gray color and the forked cerci of the male.

Melanoplus punctulatus (*Scudder*).

Olive yellow; sides of pronotum with a black patch; hind femora with deep wine-red and olive-yellow bands, underside of femora crimson; tibiæ dirty red with a yellowish band at the base; tarsi with last joint tipped with black; wing covers olive brown with scattered black spots; hind wings pellucid, yellowish at base, dusky toward the apex; cerci of male flat, basal half narrow, outer half suddenly expanding, especially on one side; antennæ of male quite long.

Measurements.—Male: Length of body, 20–23 mm.; wing covers, 19–21 mm.; posterior femora, 11 mm. Female: Length of body, 25–29 mm.; wing covers, 17–18 mm.; posterior femora, 12–13 mm.

The habits of this species are very different from those of the other members of the genus. Instead of being an active creature, and living on the ground amongst the grass like other species of *Melanoplus*, it inhabits pine trees, and is sometimes found in numbers on the same tree. It is quite sluggish, and may be easily taken without making any or much effort to escape capture. Found during August and September. It is quite scarce in this vicinity, but rather common in certain parts of Connecticut and New York in the pine woods.

Melanoplus minor (*Scudder*).

Head and thorax grayish or brown; legs dirty yellow; hind femora brownish outside with traces of darker bands, underside orange; hind tibiæ lead color, or dull reddish in some individuals. Underside of body pale yellow; wing covers brown with a few small black spots along the middle; hind wings dusky at the apex, cinereous towards the base. Wing covers reaching the tip of the abdomen; cerci of male quadrate at base, somewhat compressed, longer than broad. outer portion rounded at tip, narrower than basal part, bent upward and grooved at the apex.

Measurements.—Male: Length of body, 17 mm.; wing covers, 12.5 mm.; posterior femora, 11 mm. Female: Length of body, 22 mm.; wing covers, 18 mm.; posterior femora, 12 mm.

Found during June and in July in dry grassy places, along the Palisades and in Westchester County, N. Y. Common locally. It may be readily known by its lead-colored hind tibiæ.

Melanoplus borealis (*Fieber*).

This species very much resembles *M. femur-rubrum*, but the wings and wing covers are much shorter than the body; the transverse furrow of the anterior lobe of the pronotum is indistinct, and upper half of the divergent lobes much darker than the pale lower half. Cerci of male nearly equal throughout.

Measurements.—Male: Length of body, 16 mm.; wing covers, 9 mm.; hind femora, 9 mm. Female: Length of body, 21 mm.; wing covers, 10 mm.; posterior femora, 12 mm.

Taken on the cranberry bogs at Jamesburg, N. J., during July and August.

Melanoplus bivittatus (*Say*).

PLATE VIII, FIG. 8.

Yellowish green or grayish green, upper side of head and pronotum deep brown, the former with two yellow lines on top, continued along upper sides of the pronotum and extending to nearly the tip of the wing cases; underside of abdomen yellow; wings extending to the tip of the abdomen; femora marked with black outside, hind tarsi red; antennæ rufous.

Measurements.—Male: Length of body, 28 mm.; wing covers, 20 mm.; hind femora, 15 mm. Female: Length of body, about 38 mm.; wing covers, 24 mm.; hind femora, 20 mm.

This is the largest and clumsiest species of *Melanoplus* found in this vicinity. It may be readily known by the two yellowish stripes along the back. It inhabits damp or swampy meadows, covered with weeds and tall grass. Common from July to October.

Pezotettix *Burmeister*.

Allied to *Melanoplus*, but the wings and wing covers are absent or abbreviated.

Pezotettix scudderi *Uhler.*

PLATE VIII, FIG. 6.

Fusco-ferruginous; wing covers extending a little beyond the second abdominal segment; posterior femora yellow on the underside; hind tibia red with a black ring near the base.

Measurements.—Male, 16–17 mm. Female, 22–23 mm.

Not common in this neighborhood. Found from the latter part of August until the latter part of October, in dry places.

TETTIGINÆ.

Tettix *Latreille.*

Size small; form slender; head small, eyes globular, protruding; antennæ 13–14-jointed; pronotum compressed anteriorly, median carina distinct, hind portion extending back over the abdomen to or beyond its extremity, and terminating in a long narrow point; wing covers very short; wings fan-like, well developed, almost as broad as long, and as long or longer than the abdomen; lower anterior angle of sides of pronotum angulated and bent inward.

Tettix granulatus (*Kirby*).

Wholly grayish brown, and finely granulated; narrow, slender; pronotum much longer than the abdomen; vertex prominent, advancing in front of the eyes, with the front border angulated.

Measurements.—Length of body, 11 mm.; pronotum, 13 mm.; hind femora, 6 mm.

Found along roadsides, usually in damp places, from April to September.

Tettix cucullatus (*Burmeister*).

Resembles *T. granulatus*, but the vertex is narrower and does not project beyond the eyes; the front of the vertex is cut square and is not angulated as in *T. granulatus*. The pronotum is also broader and the median carina less distinct.

Measurements.—Length of body, 10 mm.; pronotum, 12 mm.; posterior femora, 6 mm.

Found in similar localities as the preceding species.

Tettix ornatus (*Say*).

Smaller than *T. cucullatus*, with various styles of ornamentations. Vertex slightly advancing beyond the eyes, with the front border rounded and the median carina projecting; pronotum extending beyond the abdomen. In color it is cinereous, with yellowish and black markings.

Measurements.—Length of body, 10 mm.; pronotum, 11 mm.; posterior femora, 5 mm.

Found from April until September.

Tettix triangularis (*Scudder*).

Allied to *T. ornatus*, but differs by having the pronotum slightly extending beyond the tip of the abdomen, and not prolonged into a long slender point as in *T. ornatus*.

Measurements.—Length of body, 9 mm.; pronotum, 9 mm.; posterior femora, 5 mm.

It is considered as a variety of *T. ornatus*, and is found in the same localities.

Tettigidea *Scudder*.

Size small; form robust and clumsy; head large and broad, with the front less sloping and with median ridge of the face more prominent than in the genus *Tettix;* antennæ 21–22-jointed; lower anterior angle of sides of pronotum rounded and not bent inward as in *Tettix;* front border of the pronotum thrust forward and partly concealing the head; median carina straight, somewhat curved anteriorly; lateral carina less prominent than in *Tettix*, and not so strongly bent inward in advance of the broader portion of the pronotum.

Tettigidea lateralis (*Say*).

PLATE X, FIG. 7.

Head and sides of body blackish brown; hind femora with a rather large ochraceous spot outside about the middle; underside of body dirty yellow; top of pronotum light or dark testaceous, sometimes the same color as the sides of the body, with a testaceous border. In the male the face and lower anterior portion of the pronotum are yellow. Wings and pronotum extending beyond the abdomen, wings somewhat longer than the pronotum.

Measurements.—Male: Length of body, 10 mm.; pronotum, 11 mm.; posterior femora, 6 mm. Female: Length of body, 14 mm.; pronotum, 15 mm.; posterior femora, 7.5 mm.

Found from April until September.

Tettigidea polymorpha (*Burmeister*).

PLATE X, FIG. 8.

Closely allied to *T. lateralis* in color and form, but the pronotum extends to the tip of the abdomen, and the wings are somewhat shorter.

Found in the same places and time as *T. lateralis*.

Batrachidea *Serville*.

Head somewhat enlarged and the space between the eyes distant; antennæ 12-jointed; pronotum reaching the extremity of the abdomen, with the median carina very high and arched; legs stout.

Batrachidea cristata (*Harris*).

PLATE X, FIG. 9.

Vertex projecting beyond the eyes, front border well rounded, a little angulated; median carina sharp, prominent, and sloping backwards; the pronotum is finely granulated, usually with two black spots on each side near the anterior portion above, otherwise the insect is wholly fuscous.

Measurements.—Length of body, 10 mm.; posterior femora, 5.5 mm.

Found from April to October. *B. carinata* is considered a long-winged variety of *B. cristata*.

Synopsis of Species of Acrididæ.

Truxalis.

Face very oblique; vertex in form of a long, blunt cone or pyramid; antennæ flattened.

Color, green and brown; wings and wing covers extending beyond the abdomen........ ....*T. brevicornis.*

Opomala.

Head as in *Truxalis.*

Color, light brown; wings and wing covers much shorter than the abdomen ....*O. brachyptera.*

Chloëaltis.

Top of head rounded; vertex produced into a short, blunt pyramid; pronotum parallel.

Green or brown; wings shorter than the abdomen (female) or nearly as long (male)... ....*C. viridis.*

Wings of female extending to the tip of the abdomen....var. *punctulatus.*

Grayish brown speckled with black; hind femora with two light patches outside; sides of pronotum marked with black (female) or wholly black (male)............... ....*C. conspersa.*

Stenobothrus.

Pronotum constricted before the middle; head similar to *Chloëaltis*; body slender and narrow.

Green and brown; wings and wing covers extending beyond the abdomen .... *S. maculipennis.*

Nearly like *maculipennis*, with the vertex more angulate with front in profile .... *S. olivaceus.*

Wings and wing covers extending to tip of the abdomen ...... *S. æqualis.*

Wing covers yellowish, shorter than the abdomen; hind tibiæ red, knees black .... *S. curtipennis.*

Wings and wing covers as long or longer than the abdomen, var. *longipennis.*

Chortophaga.

Pronotum acutely angled behind; median carina elevated.

Grass green; wing covers sometimes with brown stripe; hind wings yellowish green at base, translucent .... *C. viridifasciata.*

Dusky brown, wing covers with darker patches .... var. *infuscata.*

Encoptolophus.

Head swollen; pronotum constricted at the sides, triangular behind, median carina cut in the middle by a distinct notch.

Dusky brown; wing covers with lighter fasciæ .... *E. sordidus.*

Arphia.

Pronotum keel-shaped, arcuate, acutely angled behind.

Brown; hind wings at base bright sulphur yellow; pronotum sharply angled behind .... *A. xanthoptera.*

Smaller species, color like *xanthoptera*, pronotum triangular behind, *A. sulphurea.*

Hippiscus.

Robust species; pronotum very broad, rugose; median carina distinct, slightly notched before the middle.

Ashy lead color; wing covers with fuscous blotches, axillary fold yellowish; hind wings coral red at base .... *H. tuberculatus.*

Ashen gray with darker shades, pronotum tinged with olive green; wing covers with many large dark spots; hind wings orange red at base .... *H. phœnicopterus.*

Dissosteira.

Median carina of pronotum notched, arched on the posterior lobe, straight on anterior lobe.

Varies from sepia to rusty brown; hind wings black with a yellow outer border .... *D. carolina.*

Trimerotropis.

Median carina of pronotum not very distinct, and broken by two wide notches.

White, with fine black atoms; hind wings pale translucent, yellow at base .... *T. maritima.*

Sphæragemon.

Head tumid; vertex broad; pronotum acute angled behind; median carina elevated, compressed and notched.

Light or dark brownish fuscous, with darker markings; hind wings pale yellow at base; hind tibiæ coral red with a broad black and white band at base .... *S. bollii.*

Ashen gray, profusely marked with black; hind tibiæ coral red with a white band near the base .... *S. saxatile.*

Brown, mottled with fuscous; hind tibiæ red with an obsolete white ring near the base .... *S. æquale.*

Circotettix.

Pronotum flattened on top, acute angle behind; median carina with two notches before the middle.

Ashen gray, profusely marked with black; hind wings pale yellow at base; hind tarsi yellowish, with three indistinct black bands.. *C. verruculatus.*

Psinidia.

Small species: Head large; antennæ flattened; pronotum granulated, much compressed before the middle, median carina with two notches.

Ash colored, variegated with gray and brown. Hind wings pink or yellow at base....................................*P. fenestralis.*

Scirtettica.

Small species: Pronotum less elevated than *Psinidia*; median carina with one notch before the middle.

Ashen gray, marbled with darker markings; hind wings sulphur yellow at base; hind tibiæ red with black ring at base followed by a white and black ring...........................*S. marmorata.*

Acridium.

Large and robust species; pronotum obtuse angled behind, median carina distinct, lateral carina rounded.

Yellowish green, with a distinct yellow line running from the head to the tip of wing covers, which are brown...........*A. alutaceum.*

Leathery brown, without the yellow stripe..............*A. rubiginosum.*

Piceous, with flesh-colored and yellow stripes on the head and pronotum; wing covers covered with dark brown spots....*A. americanum.*

Paroxya.

Small species; pronotum twice as long as broad, slightly rounded behind, smooth, posterior lobe punctured.

Olive brown, face and sides yellow; behind the eyes a black stripe running to the end of the pronotum.....................*P. atlantica.*

Melanoplus.

Allied to *Paroxya*; pronotum shorter, with the lateral carina on the anterior lobes indistinct; anal segment of male swollen.

Yellowish; wing covers fuscous; hind tibiæ red; cerci of male broad at base, pointed at the tip...............*M. femur-rubrum.*

Similar to *femur-rubrum*; cerci of male about twice as long as broad, rounded at tip......................................*M. atlanis.*

Grayish; hind femora with three distinct black bands above; hind tibiæ red; cerci of male forked at the tip ....*M. collinus.*

Olive yellow; wing covers olive gray; hind femora with wine-red and yellow bands; cerci of male flat, basal half narrow, outer half expanded on one side ....*M. punctulatus.*

Grayish brown; hind tibiæ lead colored, rarely dull reddish; cerci of male quadrate at base, longer than broad, outer portion rounded at tip and narrower than basal part, bent upwards and grooved at the apex................................*M. minor.*

Like *femur-rubrum*, but the wings and wing covers much shorter than the abdomen; cerci of male nearly equal throughout, *M. borealis.*

Robust; yellowish green, with two yellow lines running from behind the eyes to the end of the pronotum and along the wing covers, *M. bivittatus.*

Pezotettix.

Allied to *Melanoplus*; wing covers abbreviated.

Fusco-ferrugineous; hind tibiæ red with a black ring at base, *P. scudderi.*

Tettix.

Minute species: Pronotum extending back over the abdomen to or beyond its extremity.

Grayish brown, finely granulated; pronotum extending much beyond the abdomen; vertex angulated, advancing in front of the eyes.................................... *T. granulatus.*

Vertex narrower, not projecting beyond the eyes; not angulated, *T. cucullatus.*

Pronotum shorter than in the two preceding species; fuscous, with various styles of ornamentation.................... *T. ornatus.*

Like *T. ornatus*, but the pronotum not extending beyond the abdomen .... *T. triangularis.*

Tettigidea.

Minute species: Allied to *Tettix*; robust; lower anterior angle of sides of pronotum rounded and not bent inward as in *Tettix*.

Hind femora with a rather large pale spot outside; top of pronotum light or dark brown, extending beyond the abdomen..... *T. lateralis.*

Allied to *T. lateralis*; pronotum reaching the tip of the abdomen, *T. polymorpha.*

Batrachidea.

Median carina much elevated, arcuate, extending to the tip of abdomen or beyond.

Fuscous, with two black spots on each side on top of the pronotum, *B. cristata.*

EXPLANATION OF PLATES.

Plate V.

Fig. 1.—*Anisolabis maritima* Bon. Female.
Fig. 2.—*Stylopyga orientalis* (Linn.). Male.
Fig. 3.— " " " Female.
Fig. 4.—*Periplaneta americana* (Linn.). Female.
Fig. 5.—*Gryllotalpa columbia* Scudder. Female.
Fig. 6.—*Gryllus pennsylvanicus* Burm. Male.
Fig. 7.— " " " Female.
Fig. 8.— " *domesticus* Linn. Male.
Fig. 9.—*Nemobius fasciatus* (De Geer). Male.
Fig. 10.— " *vittatus* (Harr.). Female.
Fig. 11.— " *affinis* Beut. Female.
Fig. 12.—*Œcanthus niveus* (De Geer). Male.
Fig. 13.— " " " Female.
Fig. 14.—*Xabea bipunctata* (De Geer). Female.
Fig. 15.—*Tridactylus terminalis* Scudder. Female.
Fig. 16.—*Phylloscirtus pulchellus* (Uhler). Male.
Fig. 17.—*Ceuthophilus grandis* Scudder. Female.

Plate VI.

Fig. 1.—*Cyrtophyllus concavus* (Harris). Male.
Fig. 2.—*Amblycorypha rotundifolia* (Scudder). Female.
Fig. 3.—*Microcentrum laurifolium* (Linn.). Female.
Fig. 4.—*Orchelimum vulgare* Harris. Male.
Fig. 5.— " " " Female.
Fig. 6.—*Xiphidium brevipennis* Scudder. Female.
Fig. 7.— " *fasciatum* (De Geer). Female.
Fig. 8.—*Conocephalus ensiger* Harris. Male.
Fig. 9.— " *robustus* Scudder. Female.

Plate VII.

Fig. 1.—*Conocephalus exiliscanorus* Davis. Male.
Fig. 2.— " " " Female.
Fig. 3.— " *dissimilis* Serville. Male.
Fig. 4.— " " " Female.
Fig. 5.—*Scudderia curvicauda* (De Geer). Male.
Fig. 6.— " " " Anal spines.
Fig. 7.—*Atlanticus pachymerus* (Burm.). Male.
Fig. 8.— " *dorsalis* (Burm.). Female.
Fig. 9.—*Chloëaltis conspersa* Harris. Male.
Fig. 10.— " *viridis* Scudder. Female.

Plate VIII.

Fig. 1.—*Truxalis brevicornis* Linn. Male.
Fig. 2.— " " " Female.
Fig. 3.—*Psinidia fenestralis* Serville. Female.
Fig. 4.—*Stenobothrus maculipennis* Scudder. Female.
Fig. 5.—*Paroxya atlantica* Scudder. Female.
Fig. 6.—*Pezotettix scudderi* Uhler. Female.
Fig. 7.—*Melanoplus femur-rubrum* (De Geer). Female.
Fig. 8.— " *bivittatus* (Say). Female.
Fig. 9.—*Chortophaga viridifasciata* (De Geer). Female.
Fig. 10.—*Arphia sulphurea* (Harris). Male.
Fig. 11.— " *xanthoptera* (Germar). Male.

Plate IX.

Fig. 1.—*Acridium rubiginosum* Harris. Female.
Fig. 2.— " *alutaceum* Harris. Female.
Fig. 3.— " *americanum* (Drury). Female.
Fig. 4.—*Hippiscus phœnicopterus* (Germar). Male.
Fig. 5.—*Spharagemon æquale* (Say). Female.
Fig. 6.—*Circotettix verruculatus* (Kirby). Female.

Plate X.

Fig. 1.—*Spharagemon bollii* Scudder. Male.
Fig. 2.—*Encoptolophus sordidus* (Burm.). Female.
Fig. 3.—*Hippiscus tuberculatus* (Pal. de Beauv.). Male.
Fig. 4.—*Scirtettica marmorata* (Harris). Male.
Fig. 5.—*Trimerotropis maritima* (Harris). Female.
Fig. 6.—*Dissosteira carolina* (Linn.). Female.
Fig. 7.—*Tettigidea lateralis* (Say). Female.
Fig. 8.— " *polymorpha* (Burm.). Female.
Fig. 9.—*Batrachidea cristata* (Harris). Female.
Fig. 10.—*Diapheromera femorata* (Say). Female.

Article XIII.—DESCRIPTIONS OF TEN NEW NORTH AMERICAN MAMMALS, AND REMARKS ON OTHERS.

By J. A. Allen.

The large additions made during the last few months to the collection of mammals in the American Museum include a number of undescribed forms, mainly from the collections of Messrs. W. W. Price and W. W. Granger. Mr. Price's collection, made in southeastern Arizona, alone numbers about 1500 specimens, one-half of which has been purchased by the Museum. The whole collection, however, has been kindly sent by Mr. Price to the Museum for determination, and will form the basis of a special paper on the mammals of southern Arizona, to be published shortly in the Museum 'Bulletin,' Mr. Price contributing his important field notes, covering nearly a year's work of himself and assistants. In addition to the several new species discovered, his observations and collections greatly extend the hitherto recorded range of many species of mammals. Thus the known range of *Tamias cinereicollis*, *T. lateralis*, *Sciurus hudsonius mogollonensis*, *Arvicola alticolus*, and *Sitomys americanus rufinus* has been carried from the San Francisco Mountains southeastward along the Pine Plateau region to the White Mountains, and some of them to the Chiricahua and Graham Mountains; and the large *Nyctinomus macrotis nevadensis*, described by Dr. Harrison Allen from Nevada, has been found by Mr. Price in the Chiricahua Mountains. Much light has also been thrown upon the range of various other species in southern Arizona.

Mr. Granger's collection, numbering over 500 specimens, collected mainly in South Dakota, contains several species new to the fauna of the Black Hills region, and will also be made the subject of a special report.

The measurements given in the following paper were taken by the collector from the fresh specimen before skinning, unless otherwise stated.

Perognathus pricei, sp. nov.

Above gray, lined with black ; no fulvous lateral line ; beneath white ; tail strongly crested penicillate, dark above, becoming blackish distally, white below ; ears dusky ; feet grayish white, soles naked. Pelage rather harsh but not spiny.

Measurements.—Total length (type), 157 mm.; tail vertebræ, 90 ; pencil at tip of tail, 10 ; hind foot, 23 ; ear, 7.5. Average of 5 adult specimens (4 ♂♂, 1 ♀) : Total length, 151 ; tail vertebræ, 82 ; hind foot, 22 ; ear, 8.

Skull.—Total length, 23 ; basilar length,[1] 18 ; mastoid breadth, 12 ; length of nasals, 8 ; breadth of interparietal, 8 ; greatest length of interparietal, 4 ; length of mastoid area, 12. The interparietal is large, distinctly pentagonal, twice as broad as long. The mastoid area is correspondingly reduced.

Type, No. $\frac{8859}{6685}$, ♂ ad., Oposura, Sonora, May 31, 1894 ; B. C. Condit (Price Collection).

Named for Mr. W. W. Price, in recognition of his important mammalogical explorations in southern Arizona.

This species is based on 5 adult specimens (4 males and 1 female) taken at Oposura, Sonora, May 30 and 31, 1894, by Mr. B. C. Condit, of Mr. W. W. Price's Arizona Expedition.

This species appears to bear no close resemblance to any hitherto described. In color it somewhat resembles *P. intermedius* Merriam, which is, however, a much larger species, with very different cranial characters, and not nearly so clear gray.

Perognathus conditi, sp. nov.

Above yellowish gray, lined with black ; a broad pale fulvous lateral line ; feet and lower parts white ; ears grayish dusky ; tragus about as high as broad ; tail dusky above, white below, not crested, and only very slightly tufted at the end. Soles naked.

Measurements.—Total length (type), 197 mm. ; tail vertebræ, 88 ; hind foot, 27 ; ear, 10. Another specimen (♂ ad.), measures : Total length, 193 ; tail vertebræ, 87 ; hind foot, 24.5 ; ear, 12.

Skull.—Total length, 29 ; basilar length, 24 ; greatest mastoid breadth, 14 ; length of nasals, 10.5 ; breadth of interparietal, 7 ; greatest length of interparietal, 5. The interparietal is large, pentagonal, with the posterior lateral borders much rounded ; mastoid area only moderately developed.

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[1] Front border of intermaxillæ to posterior border of occipital condyles.

Type, No. $\frac{8860}{6686}$, ♂ ad., San Bernardino Ranch, southeastern corner of Cochise Co., Arizona, March 23, 1894; B. C. Condit (Price Collection).

Named for Mr. B. C. Condit, an associate of Mr. Price in his explorations in Arizona.

This species should probably be compared with *P. baileyi* Merriam from Sonora, but it is apparently smaller, more fulvous, with the tail less crested, and the interparietal more pointed in front and more rounded on the postero-lateral borders.

Represented by 3 specimens (1 ad. ♂, 1 young ad. ♂, and 1 ♂ juv.) taken at San Bernardino Ranch, Cochise Co., Arizona, March 23 and May 1, 1894. The young specimen is grayer and less fulvous than the adults, the type being scarcely distinguishable in color from Kansas and South Dakota specimens of *P. paradoxus*, and the tail is quite as sparsely haired. In fact, in point of color, *P. conditi* is not readily distinguishable from specimens of *P. paradoxus* from the southeastern base of the Black Hills; and cranially the differences are by no means strongly marked.

Reithrodontomys mexicanus fulvescens, subsp. nov.

Above yellowish brown, more or less heavily lined with black; a bright, strongly marked fulvous lateral line; below whitish, the basal two-thirds of the pelage plumbeous; ears dusky externally, rusty within, well clothed with fine short hairs; tail indistinctly bicolor, pale brown above, lighter below, sparsely haired, but the hairs pretty thoroughly concealing the annulations; feet soiled white, heels sparsely covered as far as the first tubercle with fine short hairs.

Measurements.—Total length (type), 183 mm.; tail vertebræ, 102; hind foot, 19; ear, 14. Average of three adults (2 ♂♂, 1 ♀): Total length, 172; tail vertebræ, 99; hind foot, 19.3; ear, 14.7. Eight adult specimens of *R. mexicanus* from Brownsville, Texas, average: Total length, 178; tail vertebræ, 98; hind foot, 20.

Type, No. $\frac{8411}{6786}$, ♂ ad., Oposura, Sonora, June 1, 1894; B. C. Condit (Price Collection).

This subspecies is represented by three adult specimens taken by Mr. B. C. Condit at Oposura, Sonora, May 31 and June 1, 1894. It presents an astonishingly close resemblance, in size and proportions, to September specimens of *R. mexicanus*[1] from

[1] The type locality of *R. mexicanus* (Saussure) was Tehuacan, State of Puebla, Mexico, from which region, however, no material is at present available for comparison.

Brownsville, Texas, but the pelage is softer and fuller, and the color above more strongly yellowish ; the tail and heels are also slightly more hairy ; but it is far from certain that these differences are not in large part seasonal, though hardly probable.

The Price Collection also contains 6 specimens of *R. megalotis* from Fairbank, Arizona, and 5 specimens from the Chiricahua Mountains that seem indistinguishable from *R. longicaudus.* The series of *R. megalotis* is from very near the type locality of the species.

Arvicola leucophæus, sp. nov.

Middle region of upper parts suffused with pale reddish brown, conspicuously lined with black, and slightly tinged with gray ; sides grayer and less reddish, and less lined with black ; underparts strongly whitish gray, the fur plumbeous at base with long whitish tips, concealing the plumbeous underfur, and giving a general whiteness to the whole underparts. Tail brown above, whitish below, of medium length. Feet dusky above, strongly washed with gray.

Measurements.—Total length (type), 173 mm.; tail vertebræ, 50 ; hind foot, 22.5 ; ear, 16. Average of 3 adult specimens (1 ♂, 2 ♀♀) : Total length, 166 ; tail vertebræ, 49 ; hind foot, 22.7 ; ear, 15.

Skull.—Total length, 28 ; basilar length, 21 ; greatest zygomatic breadth, 16 ; greatest parietal breadth, 12.5 ; least interorbital breadth, 4 ; length of nasals, 8.5 ; upper molar series, 6.5. The brain-case is broad and flat ; the interorbital region is remarkably broad ; rostrum also broad ; angle of mandible exceptionally developed, even broader and heavier than in the much larger *A. edax.* Dentition as in the *Mynomes* section generally, but the molars are narrow in proportion to the heavy development of the skull.

Type, No. $\frac{8409}{6784}$, ♂ ad., Graham Mountains, Arizona, July 18, 1894 ; Price and Condit (Price Collection).

This species is represented by 4 specimens (1 ♂, 2 ♀♀ ad., 1 ♀ juv.), taken by Messrs. Price and Condit in the Graham Mountains, Arizona, July 18 and 19, 1894. It is readily distinguished externally by the whiteness of the underparts ; the coloration above is perhaps slighty more ferrugineous than that of *A. alticolus*, which is, however, a somewhat larger species, with a relatively longer tail. In cranial characters it appears to most resemble *A. edax*, but differs from it in much smaller size, lighter dentition, relatively greater interorbital breadth, and the still greater development of the mandibular angle.

The Price Collection also contains three specimens of an *Arvicola* from the White Mountains, Arizona, which I provisionally refer to *A. alticolus.*

Sitomys americanus arizonæ, subsp. nov.

Similar in coloration to *S. a. gambeli*, but smaller, with relatively shorter tail and slightly larger ears. Above pale wood brown, slightly darker along the middle of the back, and lighter or more ashy on the sides, generally with no trace of a lateral line ; feet and beneath white, the basal half of the pelage plumbeous ; tail dusky above, grayish white below.

Young, in first pelage.—Above dark plumbeous slate ; below whitish, the plumbeous underfur showing through the surface.

Measurements.—Total length (type), 158 mm.; tail vertebræ, 67 ; hind foot, 24 ; ear, 17. Average of 42 adults : Total length, 160 (145–183) ; tail vertebræ, 65 (57–80) ; hind foot, 22.5 (20–24) ; ear, 17 (16–18).

Type, No. $\frac{8416}{6748}$, ♂ ad., Fairbank, Arizona, March 13, 1894 ; Price and Condit (Price Collection).

This is a strongly marked form of the short-tailed or *sonoriensis* group of the genus *Sitomys*, characterized by the nearly uniform brownish gray color of the entire upper parts. It is represented by a series of nearly 70 specimens, 50 of which (all adult but two) were taken at Fairbank, Arizona, Feb. 22 to March 13, 1894. This series is remarkably uniform in coloration, though the extremes vary considerably in size. Two or three specimens show a slight fulvous wash, approaching the color of a pale *Sitomys eremicus.* All the specimens of *Sitomys* obtained at Fairbank, except a few examples of *S. eremicus*, were of this form.

I also refer to this species a series of 20 specimens from San Bernardino Ranch, taken March 21 to May 4. These consist of young in various stages of immaturity, from nurslings up to breeding females which still retain the plumbeous pelage of the young. At first they were thought to represent a distinct species, characterized by a permanent plumbeous coloration, but on comparing the older examples of the series with the Fairbank specimens it became at once evident that they must be referred to

S. a. arizonæ, there being a few specimens in the San Bernardino series which completely connect the two.

The large series obtained in the White, Chiricahua and Graham Mountains are of the *rufinus* type, from which, however, some of these several mountain strains of reddish, short-tailed *Sitomys* may perhaps be separable as local races of the *sonoriensis* group.

Neotoma campestris, sp. nov.

Similar in size and cranial characters to *Neotoma micropus*, but very different in coloration. Above yellowish gray, varying to buffy ochraceous, finely lined with black-tipped hairs, which are conspicuous over the median dorsal region, and more sparingly developed on the sides; head slightly lighter and more grayish; feet, to considerably above ankles and wrists, pure white; throat, breast, middle of abdominal region, and posterior third of ventral surface pure white to base of the hairs, the pelage here long, soft and cottony; the whiteness of the underparts also extends well up on the sides of the body, where, however, the basal portion of the fur is plumbeous. Ears rather small, thinly haired, dusky, narrowly rimmed with white. Tail thickly haired, the hairs everywhere concealing the annuli, pale grayish brown above, sides and below pure white.

Young (one-fourth grown) are clear ashy gray above, more or less shaded along the middle of the back with blackish; below pure white to the base of the fur. Tail very thinly covered all round with short whitish hairs.

Measurements.—Total length (type), 388 mm.; tail vertebræ, 170; hind foot, 40; ear from anterior base (measured from dry skin), 24. Average of six adult specimens: Total length, 370; tail vertebræ, 155; hind foot, 40.5; ear from anterior base (measured in dry skin), 25.

Skull.—Similar to that of *N. micropus*, but with heavier dentition and the 'sphenopalatine vacuities' very nearly closed.

Type, No. $\frac{7768}{6742}$, ♂ ad., Pendennis, Lane Co., Kansas, May 8, 1894; W.W. Granger.

This species is represented by two adult males, four adult females, and four quarter-grown young, taken on the Smoky River, near Pendennis, Lane County, Kansas, May 8, 1894, by Mr. Walter W. Granger, and also by a single specimen taken at Fort Lyons, Colorado, Feb. 4, 1885, by Capt. P. M. Thorne, U.S.A. This latter specimen, an adult male, is in full winter pelage, and differs from the others only in the upper surface of the tail being more distinctly blackish.

This species agrees very closely in size and proportions with *N. micropus*, but the two species differ widely in coloration, the former being slaty plumbeous above instead of yellowish gray or buffy, as in the Kansas form. Twenty fully adult specimens of *N. micropus* average as follows: Total length, 371 mm.; tail vertebræ, 154; hind foot, 39. In cranial characters the two forms differ mainly in the great reduction of the sphenopalatine vacuities in *N. campestris*, which are narrowed to very fine slits, which in some specimens are as fully closed as in the *N. cinerea* group. The teeth are also rather heavier and broader. The pterygoid notch is very broad anteriorly.

This species is much larger than *N. fallax* Merriam, from Boulder County, Colorado, much less strongly colored, and lacks the peculiar character of M_3, which in *N. fallax* has "3 instead of 2 salient angles on outer side, and 2 reëntrant angles instead of 1." It is evidently much more nearly related to *N. baileyi* Merriam from Valentine, Cherry County, Nebraska, with which it agrees in size and proportions, and of which it may prove to be merely a southern form; but it is strongly buffy instead of "grizzled gray," and has the shorter palate and longer incisive foramen of *N. floridana* and *N. micropus*.[1]

Neotoma rupicola, sp. nov.

Similar in proportions and coloration to *N. campestris*, but much smaller and much paler, with much larger ears and a bushy tail. Above creamy buff, slightly darkened with black-tipped hairs, confined mainly to the middle of the dorsal region; head and face not very distinctly paler; feet and whole lower parts pure white to the base of the hairs; tail bushy, gray above, generally becoming lighter towards the tip, pure white below; ears large, grayish, thinly haired, conspicuously edged with white.

Measurements.—Total length (type), 330 mm.; tail vertebræ, 154; tail to end of hairs, 178; hind foot, 41; ear from notch (27 measured from skin). Average of 14 adults (7 ♂♂, 7 ♀♀): Total length, 336; tail vertebræ, 146; hind foot, 40.

Skull.—In cranial characters *N. rupicola* belongs to the *N. orolestes* group of bushy-tailed Wood Rats, and except in the well-developed sphenopalatine vacuities bears a general resemblance to the '*Teonoma*' section of the genus *Neotoma*.

Type, No. $\frac{8890}{6717}$, ♂ ad., Corral Draw (southeastern base of Black Hills), South Dakota, August 21, 1894; W. W. Granger.

[1] Material received since the publication of my *N. micropus canescens* shows that it is inseparable from *N. micropus*. It is interesting to note that specimens of *Neotoma* from Fort Lyon, Colorado, and Lane County, Kansas, show no approach in coloration to Oklahoma specimens of *N. micropus*.

Represented by a series of 35 specimens, taken at the southeastern base of the Black Hills, June 7 to August 28, 1894, by Mr. W. W. Granger. It includes immature examples of various ages, from one-fourth grown upward, as well as numerous adults. The seasonal variation is not very strongly marked, but the June and July specimens are rather paler and less strongly buffy than the late August specimens in fresh fall pelage. Very young specimens are pale gray above, slightly varied with dusky hairs on the back. In adults the tail above often lightens toward the tip, where it is sometimes clear white.

This species differs from *N. orolestes*, apparently its nearest ally, in its much paler coloration, smaller size, and relatively much shorter tail.

Neotoma grangeri, sp. nov.

Similar in size and coloration to *N. cinerea*, but with well-developed sphenopalatine vacuities.

Adult in summer: Above gray strongly varied with dusky, the ground color varying from clay color to pale buffy, heavily lined with black hairs; head darker, purer gray, nearly without any tinge of fulvous; tail above dusky gray, nearly concolor with the back, pure white below; feet pure white as far as wrists and ankles; ears blackish, thinly haired, very narrowly edged with white; underparts white, in thin summer pelage without plumbeous at base of fur.

Young, a few weeks old (nurslings): Ashy gray, the middle of the back strongly blackish. *Young*, half-grown: Above slightly washed with pale buff, particularly on the sides, strongly varied with black over the middle of the back, much less so on the sides.

Measurements.—Total length (type), 393 mm.; tail vertebræ, 173; tail to end of hairs, 190; hind foot, 41; ear from notch, 28 (measured from skin). Average of 5 adults (3 ♂♂, 2 ♀♀): Total length, 381 mm.; tail vertebræ, 163; hind foot, 41.

Skull.—Total length, 51; basal length, 49; greatest parietal breadth, 28; least interorbital breadth, 5; length of nasals, 19; length of incisive foramina, 12; length of palate, 9.

Type, No. $\frac{8891}{6718}$, ♂ ad., Custer, Black Hills, South Dakota, August 4, 1894. Collected by Mr. W. W. Granger, for whom the species is named.

This species is represented by 14 specimens taken at Custer, South Dakota, July 25 to August 9, and by two taken at Glendale, Sept. 8, 1894, by Mr. W. W. Granger. Five are fully adult, 6 are 'young adults,' and 5 are young, one-third to two-thirds grown. They are all very dark colored, and form a very uniform series, except one, a very old male, taken Aug. 8, which differs from all the others in having the whole upper parts bright buffy ochraceous, and the tail above very light gray, fading to whitish basally. No other specimen shows any approach to this phase of coloration, although other adults were taken the same day at the same place. This may be an adult in fall pelage, as the coat is much fuller and softer than in any of the others, but the peculiar coloration is possibly due to old age.

N. grangeri is probably merely the Black Hills representative of *N. cinerea* of the Rocky Mountains, from which it differs in having well-developed sphenopalatine vacuities, as in the *N. orolestes* group. It is much larger than *N. rupicola*, and differs from it so totally in coloration at all ages as not to require comparison with it.

These two forms of *Neotoma* are perfectly parallel, in respect to color differences, with the forms of *Sitomys* and *Tamias* occurring at the same localities, the Black Hills affording a dark phase of each, and the adjoining plains at their eastern base a light fulvous phase. Thus on the Plains we have the pale fulvous *T. minimus* in contrast with the dark *borealis* form of the *T. quadrivittatus* group in the Black Hills; in the same way the fulvous *Sitomys americanus nebracensis* contrasts with a Black Hills form closely related to the dark northern *S. a. arcticus;* and the pale fulvous *N. rupicola* of the Plains contrasts with the dark colored *N. grangeri* of the Black Hills.

Sciurus hudsonicus[1] **dakotensis,** subsp. nov.

Sciurus hudsonius var. *hudsonius* ALLEN, Mon. N. Am. Roden. 1877, p. 672 (in part).

[1] The name *hudsonicus* Erxleben has one year priority over *hudsonius* Pallas, as shown by me in 1877 (Monog. N. Am. Roden., 1877, p. 685), in commenting upon which fact I said: "Following the strict rule of priority, the name should probably be written *hudsonicus* (from Erxleben), this being the first distinctive appellation given to this form, it having apparently a priority of one year over *hudsonius*." I did not then insist upon its adoption, following the rather lax system in such matters then prevailing. The names of the several forms of the Chickaree group of Squirrels should stand as follows:

Sciurus hudsonicus (Erxl.).
Sciurus hudsonicus dakotensis Allen.
Sciurus hudsonicus douglasii (Bachm.).
Sciurus hudsonicus vancouverensis Allen.
Sciurus hudsonicus californicus Allen.
Sciurus hudsonicus fremonti (Aud. and Bachm.).
Sciurus hudsonicus mogollonensis (Mearns).

Paler and more fulvous than *S. hudsonicus*, and much less reddish. Size slightly larger ; proportions similar.

Type, No. ——, ♂ ad., Squaw Creek, Black Hills, South Dakota, July 21, 1894 ; W. W. Granger.

This is the pale form referred to by me in 1877 (l. c., p. 681) as follows : "As already noticed, in the region of the Black Hills, var. *hudsonius* loses much of its redness ; the dorsal band becomes less distinct ; the middle of the tail is paler ; and the edging of the tail is yellowish gray, instead of bright fulvous, or yellowish red as is the case in eastern specimens." A series of 7 specimens collected by Mr. W. W. Granger, in the Black Hills, South Dakota, in July and September, confirm the differences shown by the series examined by me in 1877. It is further to be noted that the black lateral line, usually so conspicuous in eastern examples taken at this season, is either entirely wanting, or only slightly indicated in Mr. Granger's specimens. Probably, as in the case of *Tamias quadrivittatus borealis*, *S. h. dakotensis* is the prevailing form northeastward to Pembina and the Turtle Mountains, as indicated in my Monograph of the Sciuridæ (l. c., p. 692, in Table XIII).

Nyctinomus nevadensis (*H. Allen*).

Nyctinomus macrotis nevadensis H. ALLEN, Mon. N. Am. Bats, 1893 (—1894), p. 171, pll. xxxiv, xxxv (" Nevada and California ").

Dr. Harrison Allen has recently described a form of *Nyctinomus* from "Nevada and California" (exact locality not stated), under the name *Nyctinomus macrotis nevadensis*, based on two immature specimens. An examination of these two specimens[1] shows that even the older one of the two (U. S. Nat. Mus., No. $\frac{15178}{36569}$, California, John Mullan) is so young as to still retain the milk incisors in the upper jaw.[2] The very short, thin, unicolor pelage also indi-

[1] I am indebted to the kindness of Mr. Frederick W. True, Curator of Mammals, U. S. National Museum, for the opportunity of examining these precious specimens. They are preserved in alcohol, but the skulls have been removed and separately preserved. They are labeled as follows: "$\frac{15178}{36569}$, *Nyctinomus macrotis nevadensis*. California. John Mullan." The labels of both the animal and the skull bear the same inscription. The other specimen is merely a skin in alcohol. The label, as nearly as can be deciphered, has on one side "*N. macrotis*, Nevada. 1052" ; on the other side, "353. Label in envelope" The California example must obviously be taken as the type of the species, although some of the details of the ear (as Fig. 3, pl. xxxiv) appear to have been drawn from the Nevada specimen.

[2] Since the above was put in type I have received from Mr. True the skull of the other specimen (U. S. N. M., No. 60660). This skull retains not only the upper milk incisors, but also the upper milk canines, although the permanent canines have cut the gum. The rest of the teeth belong to the permanent set.

Mr. True, in reply to my inquiries, kindly informs me that no information concerning the history of these specimens beyond that furnished by the labels, as above given, is obtainable.

cates juvenility. It is therefore of great interest to find in Mr. Price's collection of Arizona mammals a specimen of *Nyctinomus* from the Chiricahua Mountains referable to the same species. It is an adult male, with a well-developed gular sac. It is not only considerably larger than the type of *N. m. nevadensis*, but somewhat larger than the measurements given by Dobson (P. Z. S., 1876, p. 729) for the type of *N. macrotis.* Its resemblance in general features to *N. macrotis* is evidently strong.

The type of *N. macrotis* Gray (Ann. & Mag. Nat. Hist., IV, 1839, p. 5) came from the interior of the island of Cuba. According to Dobson (l. c.) it was a female, and appears to have been unique up to the date of Dobson's 'Catalogue of the Chiroptera,' published in 1878. Dobson, however, refers to *N. macrotis* various species described by other authors, from southern Brazil and Paraguay. As it has not been reported from either Mexico or Central America the probability, on geographical grounds, is therefore strongly against the occurrence of the true *N. macrotis* in Arizona, California, or Nevada, aside from the various discrepancies in the structure of the ears, etc., already pointed out by Dr. H. Allen as existing between *N. macrotis* and his *N. m. nevadensis.* Between the Arizona and California specimens, however, there are no differences that might not easily result from the great difference in the age of the specimens. In the California and Nevada specimens the pelage is short, thin and unicolor from base to tip, as is usually the case in young Bats in first pelage. In the older (California) example the second growth of hair appears to be coming in in patches on the chest.

In raising *N. macrotis nevadensis* to full specific rank the detailed account already given by Dr. Allen of the young may be supplemented by the following description of an adult male:

Adult Male.—Structure of the ears, membranes, etc., as already given for the young (*cf.* H. Allen, l. c.). Pelage above dull brown, slightly rufescent. the basal half whitish; below similar, but rather lighter.

Measurements.—Total length, 140; alar expanse, 410 (collector's measurements from the fresh specimen). The following are from the skin: Forearm, 58; 2d digit, metacarpal, 60; 3d digit, metac., 58, 1st phal., 23, 2d phal., 20, 3d phal., 8; 4th digit, metac., 53, 1st phal., 48, 2d phal., 2.5; 5th digit., metac., 27, 1st phal., 20, 2d phal., 3; tibia, 16; foot, 10; tail, 63, free portion of same, 34. (The measurements of the tail are only approximate, and are possibly too large, as the tail has the appearance of having been pulled out too long.) Height of ear, 24; width of same, 36.

Skull.—Total length, 23; basilar length, 21; zygomatic breadth, 12.5; mastoid breadth, 11.5; least interorbital breadth, 6; length of lower jaw, 16; height of same at coronoid, 3.5. The skull (including dentition) is in general as described by Dr. Allen, except that it is larger and heavier, with the sagittal crest continued to the occipital, and there is less depression at the junction of the frontal anal parietal segments. All the processes are heavier, as would be expected in an old skull.

Type of the above description, No. $\frac{8414}{6746}$, ♂ ad., Chiricahua Mountains, June 22, 1894; W. W. Price and B. C. Condit.

As already noted, there is a well-developed gular sac, which is said to be wanting by Dr. Dobson in both *N. macrotis* and the smaller *N. gularis;* but Dr. Dobson's specimen of *N. macrotis* was a female, and this is a feature which varies with sex and age in the same species of both *Nyctinomus* and *Molossus.*

Arvicola (Pedomys) haydenii *Baird.*

Arvicola (Pedomys) haydenii Baird was described from a single specimen from Fort Pierre, South Dakota, on the Missouri River, about 150 miles directly east of the Black Hills. In the Granger collection I find a single specimen, an adult female, of the subgenus *Pedomys,* taken on Spring Creek, at the eastern base of the Black Hills, June 22, 1894. This specimen is evidently a little larger and a little grayer than Baird's type, but agrees with it so closely, especially in the dimensions of the skull and in the peculiarities of dentition, that I have little hesitation in referring it to *A. haydenii.* Baird's description of the cranial and dental characters, as well as of the external appearance, of his *A. haydenii* is so detailed that I find little to add from the basis of the present specimen. It is, however, obviously grayer—gray mixed with black, very slightly tinged with yellowish brown, rather than yellowish brown washed with gray. Mr. Granger's measurements from the fresh specimen are as follows: Total length, 183; tail vertebræ, 45; hind foot, 25. The corresponding measurements given by Baird for his type are: Total length, 152; tail vertebræ, 38; hind foot (from dry skin), 20.5. But there is much less difference in the measurements of the skulls, which compare as follows: Black Hills specimen—total length, 30; zygomatic breadth, 17; nasals, 9; upper molar series, 7. Type of *haydenii*—total length, 29; zygomatic breadth, 16.5; nasals (not given); upper molar series, 6.4. Hence the difference in external measurements is obviously more apparent than real.

Since writing the above I have received, through the kindness of Mr. True, the type of *haydenii*, an examination of which confirms the opinion above given of the relation of *haydenii* to Mr. Granger's Black Hills specimen. Baird's type appears to have been originally an alcoholic, and to this fact may be due in part the more yellowish cast of color it presents in comparison with the Black Hills specimen.

Three other Nebraska specimens are mentioned by Dr. Coues as referable to either "*austerus*" or to "*austerus curtatus*." These have also been kindly sent to me for examination by Mr. True. Says Dr. Coues (l. c., p. 212): "A Platte River specimen (No. 3094) is identical with the type of '*haydeni*.'" This specimen is labeled "♂, Crossing of Platte, July 8, '57. Wm. S. Wood." On the back of his label Dr. Coues has written, "Exactly like '*haydeni*.'" With this opinion I heartily concur. Another specimen (U. S. N. M., No. 3055) is referred to *curtatus*, but with the remark (l. c., p. 216): "In color, almost exactly like the paler 'haydeni' stripe of *austerus*; ...." On the label is written "Platte R. (320 m. fr. Ft. Riley). Dr. W. A. Hammond." This would bring the locality in western Nebraska, about 100 miles south of the Black Hills. In coloration and size it very closely resembles the Granger specimen above recorded. These specimens indicate the extension of the range of *Arvicola haydenii* from Fort Pierre and the Black Hills southward to the North Platte River in western Nebraska.

The third specimen (U. S. N. M., No. $\frac{3241}{12117}$), collected by Dr. F. V. Hayden on Lieut. (later Gen.) G. K. Warren's Exploration of the Upper Missouri and Yellowstone, is without locality on the original label, but on a later label is credited to "Nebraska"; it was probably taken somewhere in what is now North Dakota.

It was referred by Coues to his *curtatus*. It is much smaller and somewhat paler than the others (except No. 3055), and is apparently referable to *Arvicola austerus minor* Merriam, with which it agrees closely in size and dentition.

Mr. True has also sent to me for examination what remains (the skull only) of Baird's type of his *Arvicola* (*Pedomys*) *cinnamomeus*, which demands consideration in the present connection, since this name has priority of two pages over his *A. haydenii*, in case the two should prove the same.

Arvicola (Pedomys) cinnamomeus *Baird.*

This species was based on a single specimen from Pembina, North Dakota, of which only the skull is now extant. According to Baird, it bears a close resemblance in external characters to *A. austerus*, from which it was separated in part on peculiarities of dentition, which both Dr. Coues[1] and Dr. Merriam[2] consider to be probably abnormal. After an examination of the skull, however, I find myself unable to share this opinion. In addition to the unusual character of the enamel folds of the last upper molar, as noted by Baird, there is the great length and narrowness of the whole skull, and particularly of the rostral portion, as correctly stated by Professor Baird. He also refers to the large size of the Pembina specimen, in comparison with typical (Illinois) examples of *austerus*, the greater length of the tail, the larger size of the nail on the thumb, and the smaller ears—features now impossible to verify, in consequence of the destruction of the skin. The skull, however, sufficiently substantiates the large size, and there is no good reason to question Baird's statements respecting the other differences.

I have no Illinois or Wisconsin examples of *A. austerus*, but the Museum has a large series from Fort Snelling, Minnesota (Dr. E. A. Mearns Collection). The largest skull of this series (probably referable to *A. austerus minor* Merriam) is not more than half the size of the Pembina specimen, which differs besides in numerous important cranial details. It is also to be noted that the form of *austerus* occurring over the region to the southeast-

[1] Mon. N. Am. Roden., 1877, pp. 212, 213, 217.
[2] Am. Nat., July, 1888, p. 601.

ward of Pembina is much smaller than typical *austerus* from much further south (*cf.* Merriam, Am. Nat., July, 1888, pp. 600, 601). It hence seems reasonable to consider Baird's *cinnamomeus* as distinct from any known form of the *austerus* group, and also from *A. haydenii.* Doubtless further material from the vicinity of Pembina will, sooner or later, firmly reëstablish the species.

In connection with the discovery of *Arvicola* (*Pedomys*) *haydenii* at the eastern base of the Black Hills, as chronicled above, it is of interest to note that Dr. Coues has also recorded (Mon. N. Am. Roden., 1877, pp. 216, 217) an alleged specimen of *Pedomys* from the "Black Hills" (U. S. Nat. Mus., No. 3056), taken in August, and considered as probably "a young of the year." He comments at length upon its many peculiarities, as its "extremely short" tail, whitish feet, and excessively pallid coloration. As the skull was enclosed within the skin, he appears to have made no examination of its dentition. This specimen, from which the principal parts of the skull have since been removed, is now before me. It proves not to be a *Pedomys* at all, but an undescribed species of the genus *Phenacomys*, which may be briefly characterized as follows :

Phenacomys truei, sp. nov.

Above similar in coloration to *Arvicola* (*Chilotus*) *pallidus*, but rather darker, especially over the median dorsal region, where the general pale grayish tint of the upper parts is slightly varied with dusky hairs ; below whitish gray, the basal half of the fur plumbeous. Ears of average size for the genus, thinly haired ; feet light or whitish gray ; tail very short, dingy gray, slightly darker above, but not distinctly bicolor, with a slight terminal pencil.

Measurements.—The fragmentary condition of the skin gives so poor a basis for measurement that I copy the dimensions as recorded by Dr. Coues[1] : Total length, 118 ; head and body, 101.6 ; tail vertebræ, 16.8 ; hairs at tip, 3.5 ; fore foot, 11.2 ; hind foot, 19 ; ear, 10.2 (all taken from the dry skin).

Skull.—The skull consists merely of fragments, roughly torn out of the skin. The parts available for study are the palatal portion with the molar teeth in place, and the greater part of both mandibular rami, including the teeth. The

[1] Monog. N. Am. Roden., 1877, p. 217, Table LV, specimen No. 3056. The measurements were given by Dr. Coues in inches and hundredths.

tooth pattern, while distinctively that of *Phenacomys*, differs in various details from that of any of the hitherto described species of the genus. *Upper Molars.*—M^1 with a broadly rounded anterior loop, two internal closed triangles, and two external closed triangles; M^2 with an anterior internal pyriform loop, two external and one internal triangles; M^3 with three deep internal triangles and three very slight angular projections externally. *Lower Molars.*—M_1 with an anterior trefoil, a transverse posterior loop, and three large internal and two small external closed triangles; M_2 with a posterior transverse loop, two very deep, closed internal triangles, and two very slight external angles; M_3 with three very deep internal triangles and an outer sinuous border. Length of upper molar series, 6 mm.; of lower molar series, 5.5 mm.

Type, U. S. Nat. Mus., No. 3056, Black Hills, Aug. 10, 1857; Dr. W. A. Hammond.

Named for Mr. Frederick W. True, Curator of Mammals, U. S. Nat. Mus., to whose kindness I have been many times greatly indebted for valued assistance.

The specimen upon which the above description is based is apparently full grown but quite young, as the molars are not rooted, as they become later in life in this genus. In young individuals they are only partly so[1] or not at all, as in the present specimen.

In coloration *Phenacomys truei* is much lighter than *P. orophilus* Merriam from Idaho, lacking almost entirely the abundant black-tipped hairs which in that species strongly tinge with blackish the whole median dorsal region.

The dentition of *P. truei* is peculiar in the slight development of the external triangles of all the molar teeth, both above and below, in comparison with the other described species. M_1 closely resembles the corresponding tooth in *P. latimanus*, while M_3 closely resembles M_3 in *P. intermedius*.

The discovery of a species of *Phenacomys* in the Black Hills greatly extends the known range of the genus to the southward, east of the Rocky Mountains. *P. orophilus* was described from specimens collected in the mountains of south-central Idaho, but there is a hitherto unrecorded specimen of this species in this Museum from St. Mary's Lake, northwestern Montana, collected by Dr. George B. Grinnell. This is the nearest point to the Black Hills from which *Phenacomys* has been thus far reported.

[1] *Cf.* Merriam, N. Am. Fauna, No. 5, 1891, p. 66.

Article XIV.—REMARKS ON CERTAIN LAND MAMMALS FROM FLORIDA, WITH A LIST OF THE SPECIES KNOWN TO OCCUR IN THE STATE.

By FRANK M. CHAPMAN.

During the past five years the Museum has received several collections of small mammals from Florida, containing in all about 400 specimens. They were collected for the most part at Gainesville and on the East Peninsula, opposite Micco, by the writer; at and near Micco by the late Jenness Richardson; at Tarpon Springs by W. E. D. Scott, and at Enterprise and Flamingo, near Cape Sable, by C. L. Brownell. The last-named collection has recently been received. It contains material worthy of special note, and in working this up for publication several facts of interest in connection with species represented in the other collections have been developed. These refer to so large a proportion of the land mammals of Florida that it has been decided to include all the species known from the State. The list as a whole is based on the collections above mentioned, information furnished me by friends and associates, and the following previously published lists of Florida mammals: (1) 'On the Mammals and Winter Birds of East Florida,' etc., by Dr. J. A. Allen (Bull. Mus. Comp. Zoöl., II, 1871, pp. 168–185), an annotated list of 34 species. (2) 'Catalogue of the Mammals of Florida, with Notes on their Habits, Distribution,' etc., by C. J. Maynard (Bull. Essex Inst., IV, 1872, pp. 135–148), an annotated list of 36 species. (3) 'The Mammals of Florida,' by C. J. Maynard (Quart. Journ. Boston Zoöl. Society, II, 1883, pp. 1–8, 17–24, 38–43, 49, 50), an annotated list of 36 species, containing much the same matter as the paper just cited. (4) 'Contributions to the Mammalogy of Florida,' by Samuel N. Rhoads (Proc. Acad. Nat. Sci., Phila., 1894, pp. 152–160), containing remarks on 22 species.

1. **Didelphis marsupialis virginiana** (*Kerr*). COMMON OPOSSUM.—Abundant throughout the State.

2. **Cariacus virginianus** (*Bodd.*). VIRGINIA DEER.—Abundant in the less-settled portions of the State, and occurring in small numbers in the vicinity of the larger towns and cities. Proper material will doubtless show that Florida deer constitute a well-marked subspecies, distinguished chiefly by their small size.

3. **Sciurus carolinensis** *Gmel.* SOUTHERN GRAY SQUIRREL.—A common and, in places, an exceedingly abundant animal throughout the 'hummocks' of the State. A perfectly black specimen, collected by W. E. D. Scott, at Tarpon Springs, is the only melanistic individual I have seen.

4. **Sciurus niger** *Linn.* SOUTHERN FOX SQUIRREL.—Of general distribution throughout the pineries, but is common only locally. In one of eight specimens the black of the head extends half-way down the back.

5. **Sciuropterus volucella** (*Gmel.*). FLYING SQUIRREL.—Common in some parts of the State, living in the live-oaks of the 'hummocks,' and in turkey-oaks in the pineries.

6. **Castor canadensis** *Kuhl.* BEAVER.—During a two-days' stay at Marianna in western Florida, in March, 1889, Mr. William Brewster secured reliable information concerning the occurrence of the Beaver in some numbers on Chipola River. Mr. Brewster did not see specimens or signs of the animal during his brief visit, but the character of the testimony he received was such as to place its presence beyond question. I have information also of the occurrence of the Beaver in southern Alabama.

7. **Arvicola (Neofiber) alleni** (*True*). FLORIDA ROUND-TAILED MUSKRAT.—Doubtless a common animal in favorable localities throughout the State. It is abundant on the savannas of the East Peninsula of Indian River (*cf.* this Bulletin, II, 1889, p. 119); it is not uncommon near Gainesville, and Mr. Brownell's collection contains a specimen taken at Enterprise.

In a paper by Mr. F. W. True on the relationships of this species (Report of the Smithsonian Institution for 1884, Part II, pp. 325–330, pl. ii), it is, I think, clearly shown that the characters upon which the genus *Neofiber* was based are of not more than subgeneric value.

The Muskrat (*Fiber zibethicus*) is abundant along the coasts of southern Mississippi and Alabama, and doubtless occurs in western Florida.

8. **Arvicola pinetorum** (*Le Conte*). PINE MOUSE.—Known from Florida only through Audubon and Bachman's record. It is probably restricted to the extreme northern portions of the State.

9. **Oryzomys palustris natator** *Chapm.* FLORIDA MARSH RAT.—The Museum possesses a fine series of this strongly-marked race from Gainesville, Enterprise, Micco and Flamingo.

10. **Sitomys aureolus** (*Wagn.*). GOLDEN MOUSE.—Two specimens of this species are recorded from Dummitt's by Mr. Maynard, and the Museum has two specimens from Gainesville, presented by Mr. J. Robertson. They agree with examples from North Carolina.

11. **Sitomys americanus gossypinus** (*Le Conte*). DEER MOUSE; HUMMOCK MOUSE.— Exceedingly abundant. The Museum collection contains a series of some eighty specimens of this well-marked subspecies. Of this number twenty-nine are adults with worn molars. They were taken at Gainesville, Enterprise and Micco, from February to April. Twenty-two examples, representing each of the localities mentioned, are typical *gossypinus*, with dark, blackish median dorsal area and fulvous sides. Two specimens from Micco exhibit a distinct *rufous phase*, in which the entire upper parts are almost as uniformly golden rufous as are the same parts in *Sitomys aureolus;* indeed, at first sight these two specimens would be taken for *aureolus* rather than *gossypinus*. Seven specimens, from Gainesville, Enterprise and Micco, are variously intermediate between the rufous and the dark phase of pelage, connecting one with the other by a finely graded series of changes.

Mr. S. N. Rhoads has kindly sent me the type of his recently described *Sitomys megacephalus*[1] from Alabama, and with it two specimens of *Sitomys* from Pasco County, Florida, which he has provisionally referred to that species. In my opinion these specimens are examples of *S. a. gossypinus*. There are specimens in my series of the latter form which practically match them, both in size and color. The average measurements of 14 adult males of *S. a. gossypinus* are: total length, 179; tail, 73 mm. Six females average: total length, 186; tail, 74 mm. The type of *S. megacephalus* measures, total length, 184; tail, 81 mm. The two specimens from Pasco County measure, respectively, No. 1660, ♀, total length, 203; tail, 76 mm.; No. 1702, ♂, total length, 175; tail, 75 mm. The cranial measurements in the appended table doubtless show the relative sizes of these specimens with more exactness.

	Sex.	Total length.	Orbital constriction.	Nasals.	Incisors to post-palatal notch.
S. megacephalus.					
3535.[2] Alabama......	♀	30	4.5	11.5	11.5
S. a. gossypinus.					
1702.[3] Pasco Co., Fla.	♂	28.2	4 3	10.5	11
1198.[4] Citrus Co., Fla.	♂	29.5	4.5	11.5	11.5
691. Gainesville, Fla.	♀	28.1	4.7	11	11
1053. " "	♂	28.1	4.2	11	11.5
1073. Micco, Fla.....	♂	28	4.3	10	10.2

The type of *S. megacephalus* apparently resembles *S. a. gossypinus* in coloration, and while I believe it to be a distinct form, it is obviously so closely related to *gossypinus* that a discussion of its characters based on one alcoholic specimen would be premature.

12. Sitomys floridanus (*Chapm.*). Big-eared Deer Mouse.

Hesperomys floridanus Chapman, Bull. Am. Mus. Nat. Hist. II, 1887, p. 117.
Hesperomys macropus Merriam, N. A. Fauna, No. 4, 1890, p. 53.

Seven adults from Enterprise, the type of *macropus* from Lake Worth, loaned me by Dr. Merriam, an immature specimen from

[1] Proc. Acad. Nat. Sci., Phila., 1894, p. 254.
[2] Coll. Phila. Acad.
[3] Coll. S. N. Rhoads.
[4] Coll. Miller and Bangs.

the Indian River, loaned me by Mr. G. S. Miller, Jr., and one adult and one immature specimen from Citronelle, loaned me by Messrs. Miller and Bangs, form a series which clearly shows the relationship of *floridanus* to *macropus*. Briefly, the type of *macropus* is apparently a fully adult example of *floridanus*. *S. floridanus* was described from a nursing female, the skull of which had been lost, taken by Mr. James P. H. Bell, at Gainesville. The immature specimens in the collections of Messrs. Miller and Bangs show that this type is in the gray pelage of the almost fully grown young. A tawny or fulvous line on the sides of the type shows it is changing from the immature to adult pelage. Citronelle is about forty miles southwest of Gainesville. The immature specimen from that locality is younger and therefore somewhat grayer than the type of *floridanus*, and the fulvous line on the sides appears only faintly, and on the anterior parts of the body. The adult specimen from Citronelle agrees essentially with the type of *macropus*, which the seven adults from Enterprise also resemble. The immature specimen from Indian River, however, in Mr. Miller's collection is practically a duplicate of the type of *floridanus*. It is evident, therefore, that only one species is represented in this series, to which the older name *floridanus* must be applied.

There is little to add to Dr. Merriam's description of this species. The pectoral spot mentioned by him as present in the type of *macropus* is shown by the type of *floridanus*, but by no other examples in my series. An apparently constant cranial character is found in the shape of the posterior portion of the palate, which rises at a slight angle from the palatine foramina, and has its thickened margin surmounted by two small, but evident rounded processes.

13. **Sitomys niveiventris** (*Chapm.*). GROUND MOUSE.—An abundant species on the coast of the East Peninsula, living on the ground beneath the scrub palmettoes near the sea.

14. **Sitomys niveiventris subgriseus** *Chapm.* OLD-FIELD MOUSE.—This is a darker form of the preceding, inhabiting the interior. It is abundant in fields, both cultivated and abandoned.

Some account of its habits and relationships will be found in this Bulletin, Vol. V, 1893, p. 340.

Specimens from Tarpon Springs, in Mr. Rhoad's collection, are intermediate between *niveiventris* and *subgriseus*. (*Cf.* Rhoads, l. c., p. 160).

15. **Reithrodontomys humilis** *Aud. & Bach.* HARVEST MOUSE.—Mr. Brownell's collection contains an immature specimen of this species from Enterprise. It was previously known in Florida from only one specimen taken at Tarpon Springs. (*Cf.* Rhoads, l. c., p. 161.)

16. **Sigmodon hispidus** *Say & Ord.* COTTON RAT.—An exceedingly abundant animal, of general distribution in the northern parts of the State. Say and Ord's type came from the St. John's River, doubtless from the vicinity of Jacksonville. A series from this locality in the Museum of Comparative Zoölogy at Cambridge agrees with a series from Gainesville. They differ widely from the more southern *littoralis*, and are obviously to be placed with South Carolina specimens, though, as might be expected, they are to some extent intermediate between these two extremes.

17. **Sigmodon hispidus littoralis** *Chapm.* SOUTH FLORIDA COTTON RAT.—The Museum contains a fine series of this well-marked subspecies from Enterprise, Micco, Pine Island and Flamingo. Thirteen specimens from the last-named locality, as a series, present appreciable differences from other series taken at Enterprise and Micco. They are grayer and have a rufous tinge on the rump. In some respects they suggest *Sigmodon h. texianus*. These differences are, however, in my opinion, too slight to warrant the separation of a Gulf coast race. A specimen of *Sigmodon* from Pine Island, mentioned by me in a former paper, is apparently an aged adult in unusually gray pelage.

18. **Mus decumanus** *Pallas.* NORWAY RAT; BROWN RAT.—This species is given by all previous writers on Florida mammals. I have never met with it in Florida.

19. **Mus alexandrinus** *Geoff.* WHITE-BELLIED ROOF RAT. —In my experience this is the common House Rat of Florida.

20. **Mus rattus** *Linn.* BLACK RAT.—This species appears not to have previously been recorded from Florida. Mr. Brownell's collection contains four specimens taken at Enterprise.

21. **Mus musculus** *Linn.* HOUSE MOUSE. — Abundant in settled parts of the State. New dwellings in unsettled localities are at first tenanted by the native Deer, or Hummock Mouse, but, in time, they are replaced by this omnipresent pest.

22. **Neotoma floridana** *Say & Ord.* WOOD RAT.—Of general distribution in the hummock-grown portions of the State, but, in my experience, it is nowhere a common species.

23. **Geomys tuza** (*Ord*). FLORIDA GOPHER; SALAMANDER. —An exceedingly abundant animal throughout those portions of the State which are, or were, grown with pines with an undergrowth of turkey-oaks—land of the poorest quality. In some parts of middle Florida I believe one could walk for miles stepping from mound to mound on the earth thrown up by this active miner.

There exists a puzzling confusion in regard to the common name of this species. To naturalists it is known as Gopher, or Pocket Gopher, a name generally applied to its congeners by every one familiar with them. The 'Gopher' in Florida, however, is a large land-tortoise (*Xerobates polyphemus*), which lives in large burrows in the ground, frequenting the same localities as those in which *Geomys* is found.

In a series of twenty-six specimens, six, taken in January, October and December, at Gainesville and Tarpon Springs, appear to represent a rufous phase of pelage. The remaining twenty show little variation in color.

24. **Lepus sylvaticus** *Bach.* GRAY RABBIT; 'MOLLY COTTONTAIL.'—An exceedingly abundant species, commonly frequenting plantations and 'old-fields.'

25. **Lepus sylvaticus floridanus** *Allen.* SOUTH FLORIDA RABBIT; 'MOLLY COTTONTAIL.'—A slightly darker form of the preceding species, inhabiting the southern parts of the State.

26. Lepus palustris *Bach.* Marsh Rabbit; 'Hummock Rabbit.'—An abundant animal in the marshes and lowlands, at least as far south as Gainesville in the interior, but probably not so far south on the coasts. It is replaced in the southern parts of the State by the closely-related *L. p. paludicola.*

27. Lepus palustris paludicola (*Miller & Bangs*). Marsh Rabbit; 'Hummock Rabbit.'—A series of nineteen Marsh Rabbits from Gainesville, Enterprise, Micco, Tarpon Springs and Flamingo furnishes material to more definitely establish the range and relationships of the Rabbit recently described by Messrs. Miller and Bangs[1] from the Gulf coast of Citrus County as *Lepus paludicola.* As these authors remark, and as this series proves, *palustris* and *paludicola* "show no differences in color that might not readily intergrade." Thus while *paludicola averages* darker than *palustris*, a specimen from Flamingo is but little darker than one from Summerville, South Carolina. The characters on which the new race stands, therefore, are rather those of size and proportions than color. The appended tables show a gradual decrease in size from the north southward. A comparison of the extremes shows differences worthy of recognition, but the two forms so obviously intergrade that it is evident that the southern one can claim only subspecific rank.

Measurements from the Skin.

	No.	Sex.	Total length.	Hind foot.	Ear from notch.
North Carolina[2]	...	..	435	96	60
South Carolina[3]	....	..	....	87	55
Summerville, So. Carolina	1410	♀	....	85	54
Gainesville, Fla	2793	..	440	83.5	51
" "	5650	..	430	90	48
" "	2794	♀	455	88	53
" "	2792	♀	450	90	48
" "	2795	♂	450	89	50
" "	2796	♂	450	86	50
Enterprise, "	....	♀	....	82.5	50
Micco, "	1893	♀	400	78	44
" "	1892	♂	420	78	45
" "	1893	♂	400	83	45
Tarpon Springs, Fla	2716	..	....	79	45
" " "	2718	..	....	82	44
Flamingo, "	....	♂	....	79	45

[1] Proc. Biol. Soc. Wash. IX, 1894, p. 105.
[2] Average of two males by Miller and Bangs.
[3] Average of two females by Miller and Bangs.

MEASUREMENTS FROM THE SKULL.

	No.	Sex.	Basilar length.	Length of Nasals.	Width of Nasals.	Length of Incisive Foramen.	Width of Incisive Foramen.
North Carolina[1].....	....	..	69	33	12.5	19	7
South Carolina[2].....	....	..	67	32.5	13	18	7.5
Summerville, So. Car.	1410	♀	66	31.5	14.2	18.2	6.5
Gainesville, Fla.....	1409	..	67	32	13.7	19	7
" "	1411	♂	65	33	13.8	18	7.8
" "	1412	♀	68	32	13.3	19	7
" "	1414	♀	68	33	13	18	8
" "	1415	..	69	30.5	13.1	19	7.3
Micco, "	1158	♀	60	27.5	11.5	16	7
" "	1157	♂	63	28.1	14.1	15.2	6.5
" "	1159	♂	62	28	12	16.5	7.2
Tarpon Springs, Fla.	2190	♂	62	29	13	16	7
" " "	2193	♂	63	30.5	13.2	17	7
" " "	2191	..	63	28	11.2	16	6.5

28. Artibeus carpolegus *Gosse.* LEAF-NOSED FRUIT BAT.

Artibeus perspiccillalune [sic] MAYNARD, Bull. Essex Inst. IV, 1872, p. 144; Journ. Bost. Zoöl. Soc. II, 1883, p. 22.
Artibeus perspicillatus H. ALLEN, Bats of North America, 1893, p. 43 (exclusive of synonyms).

Mr. C. J. Maynard obtained a single specimen of *Artibeus* at Key West, which was identified by Dr. Harrison Allen, from sketches, as *Artibeus perspicillatus.* There can be little doubt that this specimen was of the same species as the *Artibeus* so abundant in Cuba, of which the Museum possesses a series of 50 specimens. Since writing of these Cuban bats and referring them provisionally to *A. perspicillatus,*[3] I have secured in Trinidad six adult specimens of what I consider true *Artibeus perspicillatus.* It requires only the most superficial comparison to show that the Cuban bats are unmistakably distinct from the Trinidad species. They are much smaller, as the appended measurements show, and the facial streaks are wanting or nearly obsolete, while the Trinidad species has *four conspicuous* facial streaks which in life are plainly observable at a distance of forty feet or more. Five females from Trinidad average: forearm, 68; thumb, 12; 3d finger, metacarp., 67, 1st phal., 24, 2d phal., 38; tibia, 26.

[1] Average of two males by Miller and Bangs.
[2] Average of two females by Miller and Bangs.
[3] *Cf.* this Bulletin, IV, 1892, p. 317.

Five females from Cuba average: forearm, 54; thumb, 11; 3d finger, metacarp., 53, 1st phal., 17, 2d phal., 28; tibia, 23.

The Cuban bats agree with specimens from the West Indies identified by Dr. J. A. Allen as *Artibeus carpolegus*, under which name Mr. Maynard's record should apparently stand.

It is doubtful if this species is more than an accidental visitant in Florida. Mr. Maynard speaks of seeing high-flying bats which he supposed were the same as the specimen brought him, but *Artibeus* is a forest-inhabiting, fruit-eating bat, and is rarely observed in the open even in localities where it is abundant.

29. **Corynorhinus macrotis** (*Le Conte*). Big-eared Bat.—In his 'Bats of North America,' p. 58, Dr. Harrison Allen records a specimen of this species from Micanopy, Florida.

30. **Vespertilio gryphus** *F. Cuv.* Little Brown Bat.—This species is included by Mr. Rhoads on the basis of "several specimens" from Tarpon Springs.

31. **Adelonycteris fuscus** (*Beauv.*) Brown Bat.—Common.

32. **Vesperugo carolinensis** (*Geoff.*). Carolina Bat.—I found this to be an abundant species on the Suwanee River, as it doubtless is in other parts of the State.

33. **Nycticejus humeralis** *Raf.* Twilight Bat.—Recorded by Dr. Allen and Mr. Rhoads.

34. **Dasypterus intermedius** (*Peters*). Fulvous Bat.—In his 'Bats of North America' (1893, p. 138), Dr. Harrison Allen records a specimen of this species from Davenport, Florida, in the collection of Mr. G. S. Miller, Jr.

35. **Atalapha borealis** (*Müll.*) [=*A. noveboracensis* Auct.]. Red Bat.—Ten alcoholic specimens from Gainesville and the Suwanee River are, as has been before remarked of Florida specimens of this species, more "intensely" colored than northern examples. That is they are browner and darker. The Cuban

form, to which, without having seen specimens, Mr. Rhoads refers bats from Tarpon Springs, is, on the contrary, much lighter and brighter in color than true *borealis*.

36. **Atalapha cinerea** (*Beauv.*). HOARY BAT.—The Museum has received one specimen of this species from Mr. J. H. P. Bell, of Gainesville, taken in the vicinity of that city in February, 1891. It agrees with northern specimens, and is the first record of this species from Florida.

37. **Nyctinomus brasiliensis** *Is. Geoff.* HOUSE BAT.—Abundant.

38. **Blarina brevicauda carolinensis** (*Bach.*). SOUTHERN MOLE SHREW.—A single specimen has been recorded by Mr. Maynard from Miami, and I have taken one at Gainesville.

39. **Blarina cinerea** (*Bach.*). CINEREOUS SHREW MOLE.—"A badly-preserved specimen in alcohol from Indian River" is provisionally referred by Prof. Baird to this species.

40. **Blarina exilipes** *Baird.* SMALL-FOOTED SHREW MOLE.—One perfect specimen and one skull found in the stomach of a Barn Owl (*Strix pratincola*) taken at Gainesville, have been identified by Dr. Merriam as the above-named species.

41. **Scalops aquaticus australis** *Chapm.* FLORIDA MOLE.—Common. Three examples from Enterprise are typical of this race.

Concerning the status of *Scalops parvus* Rhoads,[1] Mr. F. W. True, who, while preparing his forthcoming monograph of the Talpidæ, has the types of both *S. parvus* and *S. a. australis* in his possession, writes me: "I have no Moles from western Florida except the type of *S. parvus*. All the characters given by Mr. Rhoads are found with greater or less distinctness in specimens from central and eastern Florida and the Carolinas, except perhaps that relating to the form of the *foramen magnum*. There

[1] Proc. Acad. Nat. Sci. Phila., 1894, p. 157.

is an approximation to this also. The characters drawn from the teeth are perhaps of little value, as the teeth are very much worn and in a peculiar manner, which gives the impression that the type was an individual kept in confinement for some time. I cannot satisfy myself that this specimen is anything more than a rather small (though adult) *australis*. It is possible, of course, that with a series at command, this view may prove invalid. In my MS. I have placed the species with a query under your subspecies *australis*, and so I shall leave it until new evidence is produced."

42. **Ursus americanus** *Pall.* BLACK BEAR.—Common in the less-settled parts of the State, particularly along the coasts, which it frequents to feed on the eggs of sea-turtles.

43. **Procyon lotor** (*Linn.*). RACCOON.—Abundant.

44. **Lutra canadensis** (*Schreber*). AMERICAN OTTER.—Generally common.

45. **Mephitis mephitica** (*Shaw*). COMMON SKUNK.—The exact distribution of the two species of Skunks which occur in Florida seems not to be known. This species is common at Gainesville, and, as far as I know, is the only one found there. Dr. Allen gives it as common on the lower St. John's, and Mr. Maynard remarks that it seems to be restricted to the more northern parts of the State.

46. **Spilogale putorius** (*Linn.*). LITTLE STRIPED SKUNK.—This is a common animal in the coast region of eastern Florida, especially in the 'scrub' of the East Peninsula. Dr. Merriam mentions a specimen from Kissimmee Prairie (N. A. Fauna, No. 4, 1890, p. 7), but I know nothing of its status in other parts of the State.

47. **Lutreola vison** (*Schreber*). MINK.—This species is included by Dr. Allen, on the authority of Mr. G. A. Boardman, as "not common." Mr. Maynard mentions seeing one at Blue Springs, and says it was "very plenty on the coast near Cedar Keys."

48. **Putorius erminea** (*Linn.*). COMMON WEASEL.—The Museum has received from Mr. J. H. P. Bell, of Gainesville, one specimen of this species (which has not previously been recorded from Florida) from Osceola. The skull is missing. The skin is more thinly furred than in northern examples; the color of the underparts is more sharply defined from and extends farther up the sides. The fore feet are white, the fore legs white on the under surface. There is a narrow white line along the outer border of the hind legs, and the hind toes are white above and below.

49. **Putorius peninsulæ** *Rhoads.* FLORIDA WEASEL.—Known only from the type specimen taken in Pasco County (*cf.* Rhoads, Proc. Acad. Nat. Sci. Phila., 1894, p. 152).

50. **Urocyon cinereo-argenteus** (*Müll.*). [= *U. virginianus* Auct.]. GRAY FOX.—Common.

51. **Canis lupus griseo-albus** (*Linn.*). GRAY WOLF.—The Wolf in Florida is now on the verge of extinction. The most recent record of its capture, of which I have any knowledge, is based on a skin purchased in Jacksonville three or four years ago by Mr. George A. Boardman. Mr. Boardman writes me: "It was killed down in Lee County, and was black as a bear. I have seen as many as half-a-dozen skins and parts of skins, and most all were black. There were no light ones such as we have north, but one or two were reddish black, lighter on the belly. The hair of all was quite short, and with no fine under-hair as in the northern wolf."

52. **Felis concolor** *Linn.* PUMA.—Confined to the less-settled portions of the State, where it is not uncommon.

53. **Lynx rufus floridanus** (*Raf.*).[1] FLORIDA WILD CAT.—Common in most parts of the State. In Brevard County (and also other counties) a bounty was offered for scalps of this animal, which resulted not only in bankrupting the county treasury

[1] *Cf.* Allen, this Bulletin, V, 1893, p. 32.

but in so great an increase of Rabbits as to threaten destruction to the crops of vegetable growers.

From many sources I have received information of the occurrence in Florida of a long-tailed, spotted Wild Cat, which may prove to be the Ocelot (*Felis pardalis*).

Article XV.—DESCRIPTIONS OF FIVE NEW NORTH AMERICAN MAMMALS.

By J. A. Allen.

As some time must elapse before the publication of the final reports on the Granger and Price Collections of Mammals, recently received by the Museum (see *antea*, p. 317), it seems desirable to place on record the following additional new forms contained in these collections.

Arvicola insperatus, sp. nov.

Apparently not readily distinguishable externally from *Arvicola longicaudus* Merriam, except that the tail is one-third shorter. In cranial characters the two species are widely different. In *A. longicaudus* M^3 has only four closed triangles, while *A. insperatus* has five, with a shorter and relatively narrower skull; the post-palatal notch is very narrow—little more than half as wide as in *A. longicaudus*, and the zygoma is much heavier—nearly twice as broad as in *A. longicaudus*. There are also many minor differences in the structural details of the skull and teeth, especially in the form of the trefoil of M^1.

Measurements.—Two adult males measure as follows: Total length, 154 and 168; tail vertebræ, 43 and 41; hind foot, 19 and 20.5 mm.

Two adult examples of *A. longicaudus*, taken at the same time and place as the above, measure as follows: Total length, ♂ (rather young), 180, ♀ (adult), 183; tail vertebræ, ♂, 63, ♀, 62; hind foot, ♂, 23, ♀, 21.

Type, No. $\frac{8105}{6781}$, ♂ ad., Custer, S. D., August 9, 1894; W. W. Granger (Granger Collection).

This species is based on 5 specimens (2 ♂♂ ad., 1 ♀ ad., and 2 ♂♂ juv., about one-third grown), taken at Custer, Black Hills, South Dakota, July 27 to August 11, 1894, by Mr. W. W. Granger.

Lepus texianus eremicus, subsp. nov.

Similar to *L. texianus* (as restricted by Dr. Mearns[1]), but much smaller. No very obvious difference in coloration.

Type, No. $\frac{9084}{7827}$, ♀ ad., Fairbank, Arizona, March 5, 1894; Price and Condit (Price Collection). Total length, 565; tail vertebræ, 74; hind foot, 123; ear from crown, 128 mm.

Dr. Mearns in his discussion (l. c.) of the proper application of the name *Lepus texianus* Waterhouse very properly, I think,

[1] This Bulletin, II, 1890, pp. 297–301.

restricted it "exclusively to the form west of the Rocky Mountains." In his diagnoses of *Lepus alleni*, *L. callotis*, *L. texianus* and *L. melanotis*, he took for his type and as the basis of his description of *L. texianus* specimen No. 2414, Am. Mus. Nat. Hist., ♀ ad., Fort Verde, Arizona, January 8, 1885 (Dr. E. A. Mearns; orig. No. 163). Fort Verde therefore becomes the type locality of the restricted *L. texianus*.

The Hares of the *L. texianus* group appear to be separable, principally on the ground of size, into two forms, a larger northern form, occurring in central Arizona and northward, and a small southern form, found in Southern Arizona (south of the plateau region) and southward into Mexico. Eleven specimens, mainly from Fort Verde, measured in the flesh by Dr. Mearns (see his table, l. c., p. 302) give the following: Total length, 640 (580–660); tail vertebræ, 106 (70–124); hind foot, 145 (130–153); ear from crown, 171 (155–183). Dr. Merriam has published (N. Am. Fauna, No. 3, p. 76) measurements of three specimens from San Francisco Mountain and vicinity which come very close to Dr. Mearns's average of 11 from Fort Verde.

Eight specimens from the southern border of Arizona (Fairbank, Huachuca Mountains, etc.), as measured in the flesh by the collector, give the following: Total length, 580 (535–610); tail vertebræ, 90 (73–104); hind foot, 129 (123–135); ear from crown, 160 (153–170).

Note on **Lepus melanotis** *Mearns*.—The reception of some 20 specimens of *L. melanotis* during the last few months enables me to correct an error made (this Bulletin, VI, p. 169) in reference to some specimens from Rockport, Texas. The Rockport specimens include examples of both *L. callotis* and *L. melanotis*; the latter, in late autumn pelage, were mistaken for the winter phase of *L. callotis*. The two forms are evidently distinct species, whose ranges in Texas overlap. *L. melanotis*, on the other hand, as stated by Dr. Mearns (l. c., pp. 299, 300), is closely related to *L. texianus*.

Lepus sylvaticus pinetis, subsp. nov.

Similar in size and proportions to *Lepus sylvaticus arizonæ*, but much darker in coloration.

Female adult, in worn breeding pelage.—Above as dark as *L. s. floridanus*, but with a rather different general effect. Underfur dark plumbeous at the base, the apical third dark russet brown ; overhair dusky, subterminally broadly ringed with whitish and tipped with black, the color of the upper parts extending well on to the sides of the abdomen. Feet and ears much as in *L. s. arizonæ*, but darker and much more heavily clothed. Pectoral band very much darker, and the fur of the ventral surface much more plumbeous at the base.

Male adult, in fresh post-breeding pelage.—Color above about equally mixed black and whitish gray with a faint tinge of pale buff. Underfur very dark slaty plumbeous, tipped with blackish brown; overhair basally like the underfur, ringed subapically with soiled whitish and extensively tipped with black. Pectoral band plumbeous, the longer hairs tipped with fulvous gray. Fore feet externally reddish brown ; hind feet much paler.

Measurements.—Total length, ♂, 335, ♀, 425 ; tail vertebræ, ♂, 40, ♀, 58 ; hind foot, ♂, 100, ♀, 105 ; ear from crown, ♂, 69, ♀, 64 mm.

Type, No. $\frac{9041}{7586}$, ♂ ad., White Mountains, August 14, 1894 ; B. C. Condit (Price Collection).

The two specimens on which the above description is based represent a small Hare of the *sylvaticus* group, very different from the ordinary pale form of Arizona and contiguous regions, known as *Lepus arizonæ*, not only in its extremely dark coloration, but in its larger and much more heavily clothed hind feet, and relatively smaller and much more hairy ears. One of the specimens is a female in worn breeding pelage ; the other a male in fresh fall pelage.

Sciurus arizonensis huachuca, subsp. nov.

Similar to *S. arizonensis*, but upper surface nearly uniform gray, showing merely a slight trace of the broad median dorsal area of fulvous seen in *arizonensis*. There is a small nape patch of pale fulvous, and a tinge of fulvous below the surface of the pelage over the middle of the back. The fulvous area of the lower surface of the tail is slightly paler, and there is a greatly reduced amount of fulvous at the base of the hairs of the upper surface of the tail—these features correlating with the reduction in the amount of fulvous on the back.

Type, No. $\frac{9021}{7816}$, ♀ ad., Huachuca Mountains, February 20, 1894 ; W. W. Price (Price Collection). Total length, 540 ; tail vertebræ, 265 ; hind foot, 70 ; ear, 34 mm.

This subspecies is based on 4 specimens, all adult (2 ♂♂, 2 ♀♀), from the Huachuca Mountains, taken January 28 to February 20, by Messrs. Price and Condit. They are very uniform in coloration, and differ widely from a large series of true *arizonensis*, including four January specimens from the type locality of the species.

Sciurus hudsonicus grahamensis, subsp. nov.

Similar to *S. h. mogollonensis*, but slightly yellower and less rufescent above, with the central area of the lower surface of the tail grayish white from the base to the end of the vertebræ, and the base of the hairs of the middle area of the upper surface of the tail yellowish ochraceous, forming a prominent median band of this color.

Type, No. $\frac{9018}{7808}$, ♀ ad., Graham Mountains, Arizona, August 18, 1894 ; Price and Condit (Price Collection). Total length, 330 ; tail vertebræ, 132 ; hind foot, 53 ; ear, 28.

The three adult specimens from the Graham Mountains, on which this new form is based, measure as follows :

Sex.	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
♂	325	130	57	28
♂	340	140	56	27
♀	330	132	53	28

A few specimens from the San Francisco and White Mountains show a slight tendency to a grayish median area along the lower surface of the tail, but it is never so pronounced and conspicuous as in the specimens from the Graham Mountains. In true *S. h. mogollonensis* the basal portion of the hairs of the upper surface of the tail are more or less fulvous, but as a rule it is not at all pronounced, whereas in the Graham Mountains specimens it is a conspicuous feature.

While *S. h. grahamensis* is apparently not a very strongly differentiated form it seems to well warrant recognition, especially when considered in relation to its fairly isolated habitat. While the White Mountains form merely the eastern end of the elevated pine plateau extending westward to the San Francisco Mountains, the Graham Mountains are south of the plateau region, from which they are separated by a comparatively low arid plain. Mr. Price (in letter of Oct. 12, 1894) writes : "Finding *Sciurus hudsonius* var.? in the Graham Mountains was interesting. It could not possibly have come in recent times from the White Mountains, as the dry desert of the Gila River lies between. The Graham Mountains rise abruptly from the plain to about 10,500 feet above sea level, and are very isolated."

Article XVI.—ON NEW FORMS OF MARINE ALGÆ FROM THE TRENTON LIMESTONE, WITH OBSERVATIONS ON BUTHOGRAPTUS LAXUS HALL.

By R. P. Whitfield.

Plate XI.

In 1861 Prof. Hall[1] described what he evidently supposed to be a graptolitic body, from shales of the age of the Trenton limestones of New York, found at Platteville, Wisconsin, under the name *Buthograptus*, giving the species *B. laxus* as the type; and in the 'Canadian Organic Remains,' Decade II, on page 49, he mentions it again as "doubtfully" referable to the Graptolitidæ. In the next paragraph he speaks of an associated form having a general resemblance to *Dendrograptus*, and says "without farther knowledge, I refer these fossils, with hesitation, to the genus *Oldhamia* (*O. fruticosa* Hall)."

In working over the fossils described in the 'Report of Progress' of the Wisconsin Geological Survey for 1861, the types of most of which are the property of the Museum, for illustration in the Museum publications, I have become convinced that these remains are not of Graptolitic origin, but are true Marine Algæ.

These bodies are found preserved on surfaces of a brown carbonaceous shale, and are seen on the surface as black lines. When examined under a sufficiently strong glass they are found to be composed of a black, coaly matter, having the lustre and fracture of anthracite, the carbonaceous character of the shale being undoubtedly derived from this source, as there are but few other organic remains found in the same layers with them.

Buthograptus consists of a midrib, flattened as seen on the shale, which gives origin to a series of short, slender, slightly curved pinnules on either edge, somewhat closely arranged, and presents a feather-like aspect as it lies on the rock. There are no definite serratures or cells on either the midrib or on the lateral pinnules, but along the line of the midrib may sometimes be seen a series

[1] Rep. Prog. Geol. Surv. Wis., 1861, pp. 18 and 19.

of dots or punctures which were supposed to represent the apertures of cells, analagous to those of Graptolites, but which now prove to be only depressions in its surface. When the stipe is placed under a sufficiently strong lens it is readily seen that the lateral pinnules are not a part of the central stipe, but are separate organs articulated by a club-shaped end to the central stipe; and it is the imprints of these club-like ends that has produced the punctures that in the description of *Buthograptus* are described as "oval spots marking the form and place of the cellules." No positive evidence has as yet been detected of articulations in the midrib or central stipe, and no really negative proof can be shown. The pinnules where perfectly preserved increase in width outwardly, from just above the club-shaped attachment to nearly twice that width near their extremity, and are rounded or obtusely pointed at the outer end.

The absence of proper cells, taken in connection with the other features above mentioned, led me not only to question the animal origin of *Buthograptus*, but to examine critically the so-called *Oldhamia fruticosa* Hall, which is associated with it, and on placing them under a sufficiently high magnifying power the Algous characteristics were at once detected in their mode of growth and in the jointed bifurcations of the branches. This has led me to the conclusion that they are both of vegetable origin and belong to the true articulated marine Algæ. This was to me a somewhat astonishing result, as I can find no record of any *articulated* marine Algæ described from Palæozoic rocks.

Among the living forms of marine Algæ on the Florida coast and elsewhere we have a form known as *Caulerpa plumaris*, which to the naked eye is so exactly a counterpart of *Buthograptus laxus* that a figure of one would answer equally well for that of the other, but when examined more carefully it is seen that in the living form the lateral pinnules are simply ramifications from the central axis or stipe, while in *Buthograptus* they are articulated pinnules which by maceration were readily separated from the central axis, as is plainly seen in the fossil specimens. The form of *Buthograptus* when living was most probably plumose with a cylindrical axis from which a series of pinnules arose on two opposite sides, not quite opposite to each plate 11

other at their origin but slightly alternating. These pinnules were probably cylindrical and somewhat club-shaped or enlarging outwardly, and attached to the axis by the knob-like inner end. In the shale, by compression, these rounded parts are all flattened, so there is little left beyond the brown staining on the rock from the carbonaceous material of the plant substance.

The name *Buthograptus* (or *Bythograptus*, as written by several authors) is a misnomer and misleading, as the termination "graptus" seems to ally it with the Graptolitidæ, which we now see to be incorrect. Such a name as *Bythocladus* would be much more appropriate.

Referring again to the supposed *Oldhamia*, I find but little similarity between it and the true *Oldhamia antiqua* Forbes, which occurs fossil in the Cambrian of England, and is the type and only species of the genus, the other species formerly included having been removed under the name *Murchisonites radiatus*. The *Oldhamia antiqua* has been considered by some authors as a Nullipore, by others as a Sertularian; the first a vegetable, the other an animal. The mode of growth seen in these Trenton forms positively indicates their vegetable character.

In very many of the marine Algæ, the stems, branches and branchlets have a peculiar jointed structure, very much like that of a Cactus, with an expansion at the upper end of the joints, the divisions being two, three, or more. This structure is very beautifully shown on some specimens of the one called *Oldhamia fruticosa* by Prof. Hall, especially on the terminal branches. (See Plate XI, Figs. 7 and 8.) Two other forms are found on the same shales, one having long slender stipes with numerous branches, long and filiform, which are joined to the principal stipe by a knob-like end, which is rather set upon the stem than joined to it. These differ entirely from the first-mentioned species, but were included with it in the article in the 'Canadian Decade.' None of them have been positively seen bearing other than the fine filiform branches. A third form occurs which has a strong middle stem, jointed, and having whorls of very fine hair-like pinnules at each joint, and much resembles some species of the genus *Wrangelia*, or perhaps more like *Dasycladus* among our living forms of Algæ.

The occurrence and detection of marine Algæ of a character so very similar to our living forms in rocks of the age of the Trenton limestones of New York, I take to be a matter of some interest and of more than passing importance, as all the various forms of marine plants and sea weeds hitherto described, so far as I am aware, have been so entirely devoid of positive or definite structure, that it is often uncertain whether they may not be the results of worm burrows, tracks or trails of molluscous animals, or phenomena resulting from inorganic causes. But here we have unmistakable structure, as far as external form goes, to guide us in their determination.

Following are descriptions of the new forms here given.

Callithamnopsis,[1] New Genus.

Frond articulate, branched, branches opposite in pairs, or in whorls near the upper end of the joints, and composed of single joints between bifurcations. Type, *C. fruticosa*, Hall's sp. Geological position in the Trenton period.

Callithamnopsis fruticosa.

PLATE XI, FIGS. 4-8.

Oldhamia fruticosa Hall, Can. Org. Rem. Decade II, p. 50. Name only.

Frond consisting of thin filiform stems more or less distinctly jointed, with slender thread-like branches of half or less than half the width of the main stem, the extremities more or less bulbous where they unite with the stem or outer divisions. Outer divisions two or three, or in some cases four or more, diverging at an angle of about thirty degrees from each other, the branches being slightly curved; the whole having the appearance of a densely branched bush in miniature. Stipes and branches with parallel margins.

In some cases the terminal branches only of a frond will be found forming a group together, when they are likely to present the appearance of whorls of many branches from their overlapping and interference one with another, and so present a variety of forms. In one case, what seems to be a main stem with many branches attached, shows the upper terminal point of the stem broad and rounded at the extremity, like a young growing shoot. In some cases the outer branches are short and the bifurcations quite close together, while in others they are long and very slender and the bifurcations quite distant. I have thought these last might possibly be specifically distinct from the type specimen of *C. fruticosa*, but after further study they seem to be connected by intermediate forms enough to unite them as one and the same.

Geological Formation and Locality.—In dark brown or chocolate-colored shales of the Trenton Group, at Platteville, Wisconsin.

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[1] *Callithamnion*, a genus of Algæ, and ὄψις, resemblance.

One peculiar feature noticed by Prof. Hall of some of these bodies, which he referred to *Oldhamia fruticosa*, is that of two of the stems being twisted together like stems of a vine growing and intertwining as if for mutual strength and support. Many of these slender thread-like stems are seen to have this feature. These are long slender stipes sometimes having numerous more slender ramifications. These differ entirely from the one mentioned above under the name *Callithamnopsis*, and cannot well be placed under that genus. So far as seen no true bifurcations, like the terminal parts of that one, have been detected. The branches are attached to the main stipe by a clavate or bulbous base as in that one, but instead of having numerous jointed divisions are simple and hair-like in their extension. This form I shall designate only by specific name, leaving it provisionally under the name *Chætomorpha*, one of our living genera, and give it the specific name *prima* with the following diagnosis.

Chætomorpha? prima, n. sp.

PLATE XI, FIGS. 9 AND 10.

Slender hair-like plants with continuous stems (*i. e.* not articulated), having numerous more slender filiform branches of extreme tenuity but without known bifurcations or divisions; branches attached to the main stipe or stem by bulbous bases or discs, easily separated. Bifurcations of the main stem uncertain. Stems frequently intertwining.

Geological Position and Locality.—On shales of the age of the Trenton group of New York at Platteville, Wisconsin, associated with the *Buthograptus laxus* Hall and *Callithamnopsis fruticosa.*

A third species, evidently allied somewhat to the preceding, is noticed on three of the blocks which bear the other forms. It is quite distinct in structure as far as can be ascertained, presenting a dense tuft or feather-like form of about one and a half inches in length, and is composed of fine hair-like fibres of great tenuity which diverge from a central stem. On close examination they are seen to be in whorls about a tenth of an inch apart. If this is their true structure the nearest living genus would probably be *Dasycladus* or *Wrangelia*. For this form I would propose the generic name *Chætocladus*.

Chætocladus, New Genus.

Marine plants with jointed cylindrical stems giving off whorls of hair-like filaments at given distances.

Chætocladus plumula, n. sp.

PLATE XI, FIGS. 11–13.

Frond probably sessile, growing in tufts of one or more plume-like stems, composed of a cylindrical axis surrounded at intervals of about a tenth of an inch, by whorls of very fine leaflets presenting a feather-like tuft of three-eighths of an inch diameter.

Formation and Locality.—In chocolate-colored shales of the Trenton group at Platteville, Wisconsin, associated with *Buthograptus laxus* and *Callithamnopsis fruticosa* Hall.

About fifteen years ago, in looking over some fragments of Trenton limestone from Middleville, N. Y., I noticed some specimens resembling Corallines, and so labeled them when placing them in the cabinet, where they have remained until now, awaiting an occasion for further notice. The specimens in question have all the characteristics of the true Corallines of the present seas, and so far as can be ascertained none in which they can be said to differ. Of course they only represent detached portions of the organism, but enough remains to show the prevailing features of the species. Nothing beyond detached joints of this form of marine Algæ has hitherto rewarded the search of Palæobotanists in any of the older geological formations. Detached plates or joints of analogous bodies have been known and described under the name *Cœlotrochium* from the middle Devonian of the Eifel; and in carboniferous limestones of England other but similar bodies have been found in numbers. In the Permian rocks forms pertaining to this class of plants have been described under the generic name *Gyroporella*, while in the Upper Lias, in the Bavarian Alps, beds of limestones are said to be largely made up of *Gyroporella* and *Diplopora*. But no definitely formed organisms of the class have been noticed in the Palæozoic rocks. And it is not until we reach the more modern formations that anything very satisfactory is known of this class of organisms in a fossil state, although it is supposed that calcareous Algæ have aided very largely in the building up of the limestones of all ages. The specimens now in hand consist of branches of from half an inch in length to one and one-fourth of an inch, with a transverse diameter of nearly one-fourth of an inch. They consist of a central or longitudinal axis which is hollow and jointed, and of whorls of lateral branches or pinnules, apparently four, possibly five in number, radiating from the central axis and forming a cylindrical body in the aggregate. The pinnules of the whorls are composed of three elements each ; a first joint which diverges from the central axis gives origin to two secondary joints, while each of these supports two still smaller joints or pinnulæ. For this form I propose the generic name *Primicorallina*, with the following diagnosis :

Primicorallina, New Genus.

Articulated marine plants, consisted of elongated cylindrical fronds, composed of a central longitudinal axis, which is jointed and hollow in the fossil condition, and supports whorls of jointed pinnules from each joint ; pinnules decompound. Type, *P. trentonensis.*

These remains are of course only the calcareous coating of the real plant, the vegetable portion having been lost. The joints are irregular in form but have a generally cylindrical form.

Primicorallina trentonensis, n. sp.

PLATE XI, FIGS. 14-17.

Fronds of small size, represented by cylindrical tufts of greater or less length, and of from one-sixth to one-fourth of an inch in diameter. Axis of the frond irregularly cylindrical and jointed ; the joints count about thirty to the inch and are nearly twice as long as thick. Pinnules four, or perhaps five, from each joint of the axis, composed of cylindrical, oval or clavate joints ; those originating on the axis are of nearly an equal length with the axial joints, and each supports two others on the outer end of very nearly or somewhat shorter length, but of less thickness ; these again support each two others which are short oval in outline and of not more than half the length of the others. Bifurcations of the pinnules diverging at an angle of about thirty to thirty-five degrees to each other.

Geological Formation and Locality.—In Trenton limestone at Middleville, N. Y.

DESCRIPTION OF PLATE XI.

Figs. 1–3. **Buthograptus laxus** *Hall.* Page 351. Fig. 1, view of a block showing several stipes, nat. size. Fig. 2, an enlargement to show the manner of attachment of the pinnules. Fig. 3, a single pinnule enlarged.

Figs. 4–8. **Callithamnopsis fruticosa** *Hall.* Page 354. Figs. 4, 5 and 6, views of three specimens showing variations of form, enlarged 3 times. Figs. 7 and 8, further enlargements of two terminal portions of a fragment.

Figs. 9, 10. **Chætomorpha? prima** *Whitf.* Page 355. Fig. 9, views of two specimens each showing two stipes intertwined, one of which retains the hair-like pinnules; Figs. two diameters. Fig. 10 shows the manner in which the pinnules are attached to the stipe.

Figs. 11–13. **Chætocladus plumula** *Whitf.* Page 356. Fig. 11, view of a branch, nat. size, with a second branch on a lower lamina of shale. Fig. 12 shows the arrangement of the pinnules around the stem. Fig. 13, an enlargement showing a bifurcation and an apparent constricted or jointed character.

Figs. 14–17. **Primicorallina trentonensis** *Whitf.* Page 357. Fig. 14, fragment of shale with two stipes, nat. size. Fig. 15, enlargement 4 times of a specimen in limestone. Fig. 16, enlargement of the smaller stipe on specimen Fig. 14. Fig. 17, diagram showing a sectional view with the arrangement of pinnules around the main stem.

Article XVII.—REMARKS ON A SECOND COLLECTION OF MAMMALS FROM NEW BRUNSWICK, AND ON THE REDISCOVERY OF THE GENUS NEOTOMA IN NEW YORK STATE.

By J. A. ALLEN.

I.—NEW BRUNSWICK MAMMALS.

The Museum has recently received a second collection of mammals from Victoria County, New Brunswick, made by Mr. John Rowley, Jr., mainly during October (Sept. 27–Nov. 7), 1894. The collection numbers about 250 specimens, and contains representatives of several species worthy of note, including two additional to those obtained last year.[1] Besides large series of Marten (*Mustela americana*), Mink (*Lutreola vison*), and the more common smaller mammals, additional specimens were obtained of *Arvicola chrotorrhinus* Miller, and *Evotomys fuscodorsalis* Allen, and the genus *Synaptomys* was found for the first time in New Brunswick.

The following additions and emendations to the former list of New Brunswick mammals (l. c.) are based on Mr. Rowley's second collection, here under notice.

Synaptomys cooperi *Baird.* LEMMING MOUSE.—Two specimens, taken as follows: Female, young adult, Tobique Point, near Andover, N. B., Sept. 28, 1894. Total length, 117 mm.; tail vertebræ, 22; hind foot, 21.6. Male, young adult, Gulquac Lake, N. B., Oct. 14. Total length, 105 mm.; tail vertebræ, 21.6; hind foot, 21.6.

The capture of these specimens is of special interest, since it extends the known range of the species far to the northward of

[1] See 'Notes on Mammals from New Brunswick, with Description of a New Species of *Evotomys*.' This Bulletin, VI, 1894, pp. 99–106.

any previously published localities of its occurrence, the most northern of which are Wareham, Mass.,[1] and Alfred Center, Allegheny Co., New York.[2] In reviewing the known range of this species a few months since[3] I ventured the remark that "It evidently occurs in the East over portions of the country where it has escaped all collectors for half a century, since, as compared with other field mice, it proves to be a singularly difficult species to trap." In securing these two specimens Mr. Rowley estimates that he captured at least 1200 Meadow Mice, of which about 97 per cent. were *Evotomys gapperi;* of these latter of course only a small part were saved.

Specimens of *Synaptomys cooperi* in the Museum from other hitherto unrecorded localities are examples from Ravenna, Ohio, and Weaverville, North Carolina.

Arvicola chrotorrhinus *Miller.* RUFOUS-NOSED MEADOW MOUSE.—A single specimen of this species was taken by Mr. Rowley last year (see *antea*, p. 102) at Trousers Lake, N. B. The present collection contains four specimens, three of which were taken at Trousers Lake, Oct. 29 to Nov. 1, and the other at Gulquac Lake, Oct. 16.

Evotomys fuscodorsalis *Allen.* DUSKY-BACKED MEADOW MOUSE.—This species, based on two specimens collected by Mr. Rowley at Trousers Lake last year (*antea*, p. 103) is represented by a series of 16 specimens. Six were taken at Gulquac Lake, Oct. 12 and 13, and 10 at Trousers Lake, Oct. 27 to Nov. 2. They are very uniform in coloration, and so well agree with the type of the species that no detailed account of them is necessary. They are all apparently nearly full grown. Throwing out two that are not mature, the series ranges in measurements as follows: Total length, 133 (127–140); tail vertebræ, 38 (35–41); hind foot, 20 (19–20.5). One very large specimen greatly exceeds these dimensions, measuring as follows: Total length, 152; tail vertebræ, 46; hind foot, 20.5.

[1] Bangs, Proc. Biol. Soc. Washington, IX, 1894, p. 99-104.
[2] Merriam, *ibid.*, VII., 1892, pp. 175-177.
[3] Abst. Proc. Linn. Soc. New York, No. 6, 1894, p. 17.

Zapus hudsonius (*Zimm.*). JUMPING MOUSE.—Four specimens, Tobique Point, Sept. 27–29. The three specimens of *Zapus* obtained last year were all *Z. insignis* Miller.

Tamias striatus lysteri. NORTHERN CHIPMUNK.—A series of 6 specimens was obtained in crossing the hardwood ridges of Tobique Point, Sept. 27 to Oct. 3, confirming Mr. Rowley's supposition of last year respecting their presence here (*antea*, p. 104).

Blarina talpoides (*Gapper*). SHORT-TAILED SHREW.—Represented by a series of 13 specimens, taken at various points in the region traversed, showing the species to be not uncommon, although only a single specimen was met with last year.

The small Shrew recorded in the former list as *Sorex forsteri* is represented by a series of 62 specimens.

No Moles were collected, but Mr. Rowley obtained satisfactory evidence of the occurrence of the Star-nosed Mole (*Condylura cristata*) at Andover and along the Tobique River.

The Mole recorded in the former list as *Scalops aquaticus* is quite as likely to be *Scapanus breweri*—a point which can only be determined by the capture of specimens.

Procyon lotor (*Linn.*). RACCOON.—An error in the former paper (*antea*, p. 105) respecting the supposed abundance of this species in the Trousers Lake region may be here corrected. The statement there made on Mr. Rowley's authority was based by him on a letter from his Indian guide, whom he had good reason to believe was wholly trustworthy in such matters. It proves, however, that the amanuensis, who wrote from the Indian's dictation, either through misunderstanding or otherwise, inserted the statement in question without the knowledge of Mr. Rowley's supposed informant. Doubtless some other fur-bearing animal was referred to by the Indian guide.

This year Mr. Rowley obtained satisfactory evidence of the occasional occurrence of the Raccoon at Fredericton, N. B., but not in the Trousers Lake region.

II.—Rediscovery of Neotoma in New York.

Many years since the late Mr. John G. Bell took several specimens of a species of *Neotoma* in the Palisades at Piermont, Rockland County, New York, which were referred by Professor Baird[1] to *N. floridana*. One of these specimens is still extant in the United States National Museum.[2] So far as known to me no Wood Rats have been taken since at this locality, though it is not improbable that they still exist there, and may be taken by proper methods of trapping.

I have now to record the capture of a specimen on Storm King Mountain, Cornwall, Orange County, N. Y., about fifty miles north of New York City, and about forty miles north of Piermont. The specimen was taken in a figure-four trap by my son Cleveland Allen, Oct. 30, 1894, in trapping for game, with other lads of the Cornwall Heights School, on Storm King. The place of capture was at the base of a cliff, thirty to forty feet in height, at an elevation of about 1000 feet. The cliff is full of deep crevices, and has a talus of loose stones at its base. The place is wooded with young second-growth trees, and is in every way well adapted to the needs of *Neotoma*. Although no other examples have thus far been taken, a small colony evidently lives at this locality.

The specimen proves to be a young male, probably a 'young of the year.' It measured as follows before skinning: Total length, 386 mm.; tail vertebræ, 172; hind foot, 41; ear from notch, 31. It differs from *N. floridana* in its densely haired, sharply bicolored tail, which is black above and white below. It thus resembles *Neotoma pennsylvanica* Stone, to which it is doubtless to be referred. Whether this species is to be referred to *N. magister* Baird, as recently claimed by Mr. S. N. Rhoads,[3] may still be an open question, with perhaps the probabilities in favor of Mr. Rhoads's conclusion.

It has often been suggested that the Wood Rats taken by Mr.

[1] Mam. N. Amer., 1857, pp. 489, 490. He says: "A few specimens of unusually large size were captured some years ago [probably about 1850], by J. G. Bell, near Piermont, on the Hudson River, but I have not heard of any in intermediate localities [South Carolina and New York]."

[2] According to Dr. C. Hart Merriam, in a letter of Nov. 5, 1894.

[3] Proc. Acad. Nat. Sci. Phila., 1894, pp. 213–221.

Bell may have been brought from the South on vessels, and this theory has at last been put in type by Mr. Rhoads, in the following words (l. c., p. 221): "It is doubtful if *N. magister* ever inhabited the State of New York, and the specimens taken by Mr. Bell were probably imported in a cargo of southern lumber." Apropos of this I may state that Dr. Merriam has recently written to me in referring to the capture of *Neotoma* on Storm King (of which I had previously informed him) as follows: "Sometime ago I examined the original Bell specimen from Rockland County and found it to be *N. pennsylvanica*, as I had supposed—thus removing the theoretical objection which argued against *N. floridana* from so far North."

As is well known, there is an early and rather indefinite record of the Wood Rat in Massachusetts. Thus Dr. George Gibbs, in writing of *Neotoma occidentalis*[1] says, incidentally, ... "but evidently confound it with the wood rat, now so rare in the Atlantic States, of which I caught a specimen many years ago in Massachusetts." This record now assumes additional interest from the fact not only of the rediscovery of the Wood Rat in New York State, but from the further fact that I have recently received trustworthy information of the capture, last winter, of six specimens at Liberty Hill, in the northern part of New London County, Connecticut. They came to a barn during severe weather and were captured and thrown away. They were described as large brown rats, *with hairy tails and the belly and feet pure white*—a description of a rat that can only apply to a *Neotoma*. Their peculiarities were noted, but they were regarded as simply "strange rats," their scientific interest being unrecognized.[2]

It hence seems probable that small colonies of Wood Rats may exist at various points in southern New York and southern New England, as well as in New Jersey, Pennsylvania, and in the mountains of Virginia, all probably referable to the recently described *N. pennsylvanica*. If seen, or even captured, unless they should fall into the hands of a competent mammalogist, they would be recognized simply as 'rats,' and fail to excite further

[1] Nat. Hist. Wash. Terr., Zoöl., p. 128, 1860 (P. R. R. Expl. & Surv., Vol. XII).

[2] I regret to find that the letter conveying this information has been mislaid, and that at this writing I am unable to give the name of my informant, or the exact date of capture of the specimens. The general facts in the case are as above stated, and I have no hesitation in making the record here given.

interest. Localities suited to the habits of Wood Rats should at least receive careful attention, with the chances quite in favor of isolated colonies being here and there met with quite outside of their heretofore supposed range.

Article XVIII.—ON NORTH AMERICAN MOTHS, WITH THE DESCRIPTION OF A NEW SPECIES OF TRIPROCRIS.

By William Beutenmüller.

In the current volume of the Museum Bulletin, pages 87–98, I published some notes on North American Ægeriidæ in advance of a contemplated monograph of the family. Since then my studies have been continued, and the following notes are presented, together with a few notes on Bombyces.

Melittia hampsoni *Beuten.*

Melittia grandis Hampson, Moths of India, Vol. I, 1892, p. 203.

The name *Melittia grandis* given to an Indian species by Mr. Hampson is preoccupied by a North American species (*M. grandis* Strecker), and therefore must be changed. I propose for it *M. hampsoni.*

Trochilium pacificum *Hy. Edwards.*

Trochilium pacificum Hy. Edwards, Papilio, Vol. I, 1881, p. 180.
Trochilium californicum Neumoegen, Ent. News, Vol. II, 1891, p. 108.

The description of *Trochilium californicum* exactly agrees with the types of *Trochilium pacificum*, and I propose to unite it with the latter species. Two type males from Santa Barbara, Cal., and two type females, one from San Bernardino, Cal., and the other marked "Cal.," are in the Hy. Edwards Collection. Expanse of males, 25–29 mm.; of females, 37–41 mm.

Trochilium tibiale *Harris.*

Trochilium tibiale Harris, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 309; Morris, Synop. Lepid. N. Am. 1862, p. 138 (quotes Harris); Hy. Edwards, Papilio, Vol. II, 1882, p. 53; Packard, Ins. Inj. For. and Sh. Trees, p. 123 (quotes Harris).
Trochilium minimum Neumoegen, Ent. News, Vol. II, 1891, p. 108.

Two examples of this species are in the Edwards Collection, one from Montreal, Canada, and the other from Vancouver Island.

It was originally described from New Hampshire, and was bred from the stems of *Populus* by Harris. In the collection of Mr. Dyar is an example from Yosemite, Cal., and one in Mr. Hudson's collection from Plattsburgh, N. Y. The description of *Trochilium minimum* from Colorado tallies with the examples of *T. tibiale* in the Edwards Collection which, as far as I am aware, were compared with Harris's type in the Boston Society of Natural History.

Sciapteron palmii (*Hy. Edwards*).

Fatua palmii Hy. Edwards, Can. Ent. Vol. XIX, 1887, p. 145.

This species, it appears to me, would be better placed in the genus *Sciapteron.* It was described as a *Fatua*, which was united by me with the genus *Tarsa*[1] of Walker. The species is very closely allied to *Sciapteron simulans* (Grote), and of both only the females are known, which differ generically from *Tarsa* (♀) by having the antennæ of equal width throughout, while those of *Tarsa* are very narrow at the base for some distance then gradually thickening towards the apex, which is pointed at the extreme tip. It is not unlikely that a new genus will have to be erected for *S. palmii* and *S. simulans*, when the males are known.

Sannina opalescens (*Hy. Edw.*).

Ægeria opalescens Hy. Edwards, Papilio, Vol. I, 1881, p. 199.
Sannina pacifica Riley, Insect Life, Vol. III, 1891, p. 292.

The types of *Sannina pacifica* were examined by me, and I find that the male of this species was previously described as *Ægeria*

[1] Bull. Am. Mus. Nat. Hist., Vol. V, 1893, p. 22.

opalescens. The wings of the male are transparent, with blue-black borders and a transverse discal bar on the fore wings. The joints of the hind legs are tufted with white. The antennæ are minutely pectinated. The fore wings of the female are wholly blue or greenish black, as is also the body and legs; the hind wings are transparent, with blue-black border. The body of both sexes is blue black, and the venation is the same as in *Sannina exitiosa.*

Habitat: Colorado, Nevada and California.

Albuna pyramidalis (*Walker*).

Ægeria pyramidalis WALKER, Cat. Het. Br. Mus. pt. viii, 1856, p. 40.
Albuna vitrina NEUMOEGEN, Ent. News, Vol. II, 1891, p. 109.

This species is subject to considerable variation, and I have no doubt that the insect described as *Albuna vitrina*, from Fort Calgary, N. W. Territory, is merely one of the many varieties.

Ægeria decipiens *Hy. Edw.*

Ægeria decipiens HY. EDWARDS, Papilio, Vol. I, 1881, p. 197.
Ægeria imperfecta HY. EDWARDS, Papilio, Vol. I, 1881, p. 198.

The types of *Æ. decipiens* and *Æ. imperfecta*, which are before me, are both one and the same species, there being no sufficient characters to warrant their separation as distinct species.

Triprocris lustrans, sp. nov.

Head, body, antennæ and all the wings black with a strong metallic steel-blue reflection. Underside of wings same as above. Expanse, 31 mm. Length of body, 8 mm. One male, from Colorado, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

In color this species resembles *T. smithsonianus*, but is more metallic, and almost twice the size. At first sight it resembles a *Harrisina*, but the wings are considerably broader than in this genus.

Pareuchætes insula (*Walker*).

Halisidota insula WALKER, Cat. Het. Br. Mus. pt. iii, 1855, p. 734.
Pareuchætes cadaverosa GROTE, Proc. Ent. Soc. Phil. Vol. V, 1865, p. 245.

The type of *H. insula* Walker in the British Museum was examined by the late Hy. Edwards, and his unpublished note on the species says, "*Euchætes insula* = *E. cadaverosa* Grote."

Habitat: Cuba, Florida, Mexico, and southward.

Lycomorpha centralis *Walker.*

Lycomorpha centralis WALKER, Cat. Het. Brit. Mus. pt. ii, 1854, p. 288.
Lycomorpha notha HY. EDWARDS, Ent. Amer. Vol. I, 1885, p. 128.

The late Hy. Edwards compared his types of *L. notha* with that of *L. centralis* of Walker in the British Museum, and states in an unpublished note that both are one and the same species.

Habitat: Mexico.

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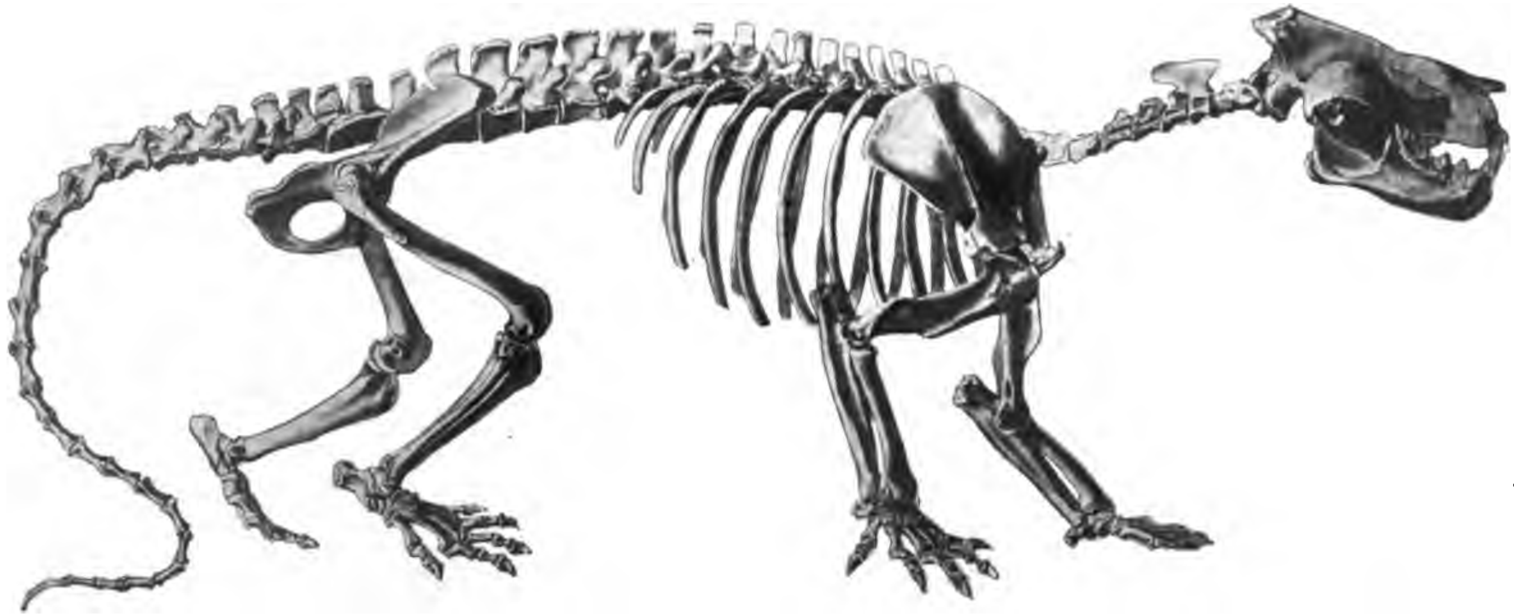


RESTORATION OF PATRIOFELIS FEROX

⅛ Natural Size.

EXPLANATION OF PLATE II.

THE LOWER MIOCENE RHINOCEROSES.

Evolution of the Skull.

Figures one-eighth natural size.

E. Aceratherium platycephalum.

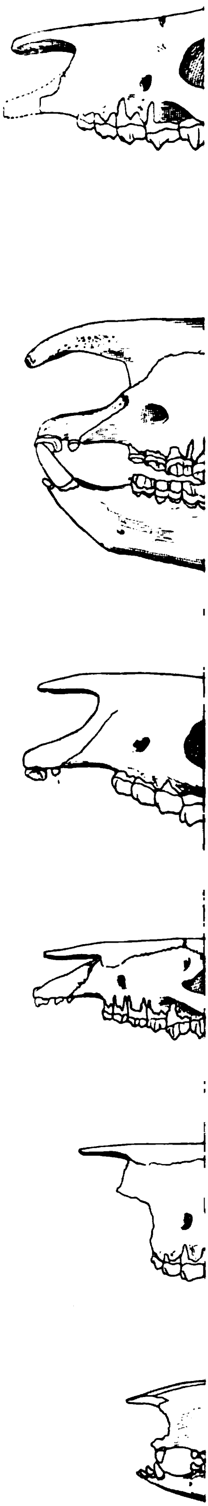
D. Aceratherium tridactylum.

C. Aceratherium occidentale.

B. Aceratherium mite.

A. Aceratherium trigonodum.

H. Hyrachyus agrarius (from the Middle Eocene, Bridger Formation).

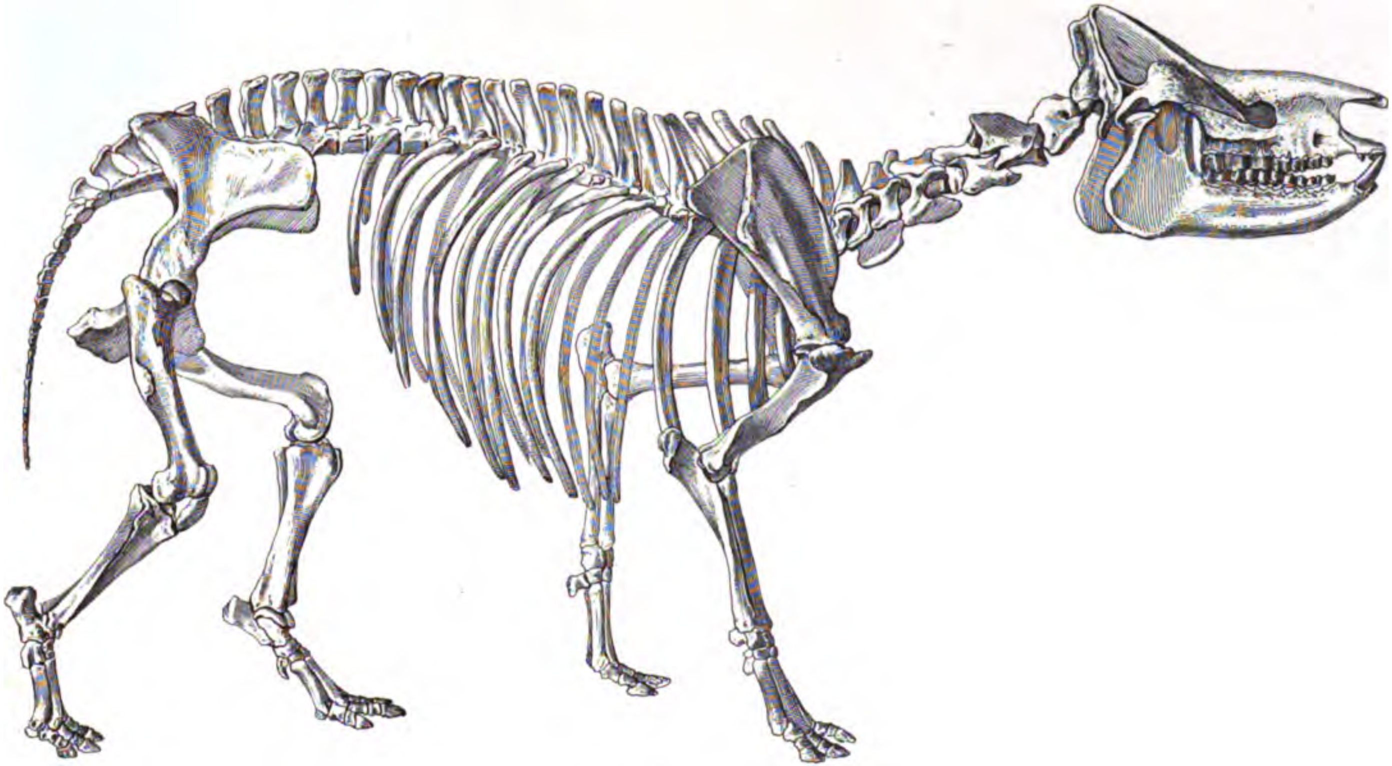


EXPLANATION OF PLATE III.

SKELETON OF ACERATHERIUM TRIDACTYLUM.

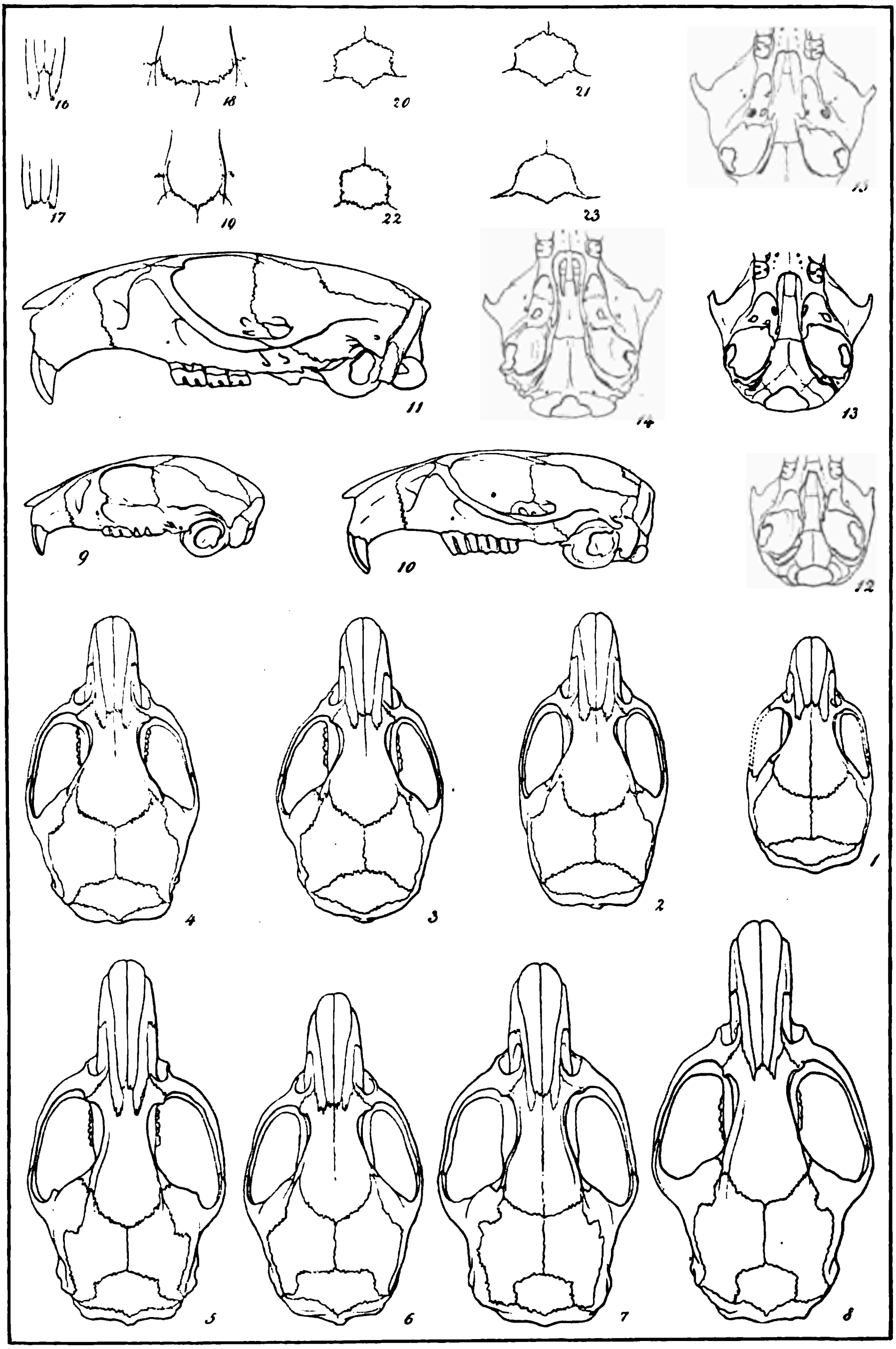
One-tenth natural size.

All parts are preserved and mounted as here represented, excepting: the left fore limb, which is restored from the right side, the great trochanter of the femur, and one or two caudals.



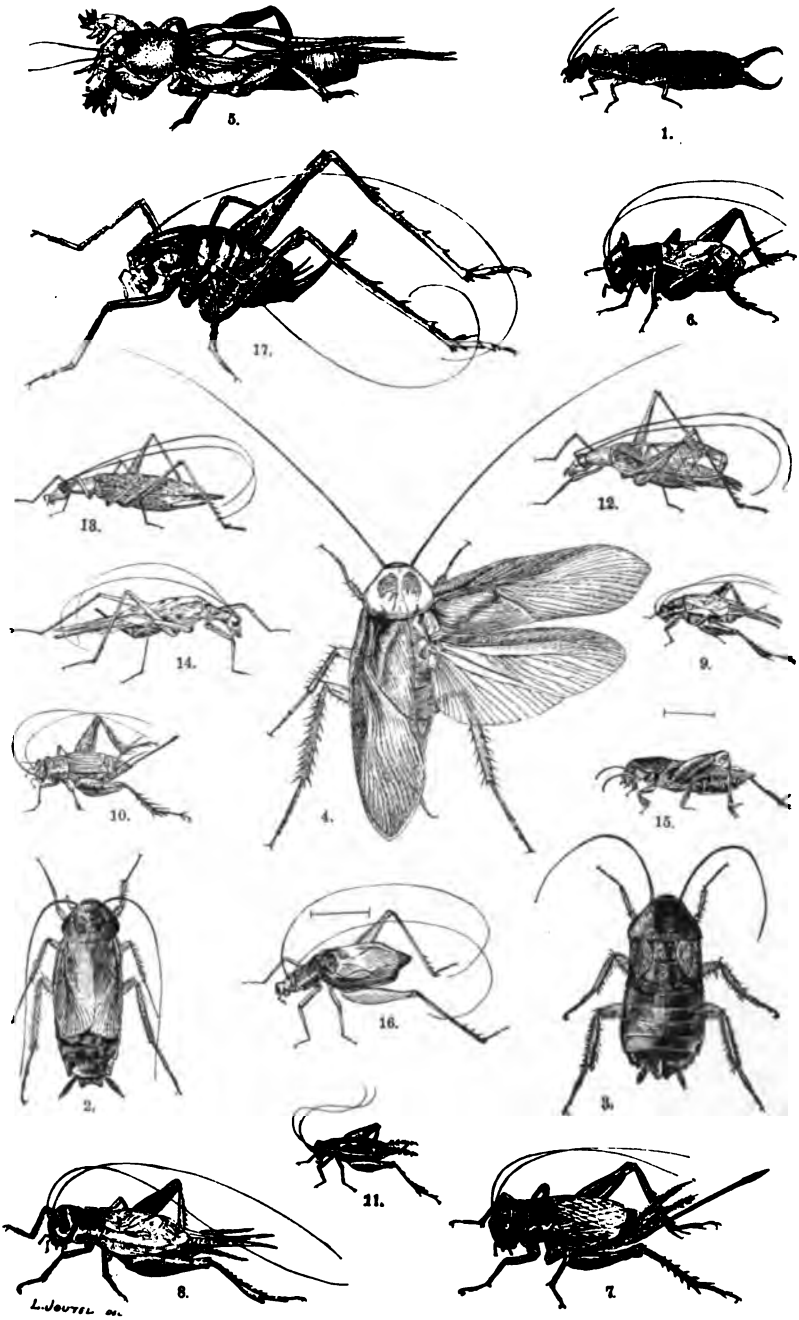
ACERATHERIUM TRIDACTYLUM.

One-tenth natural size

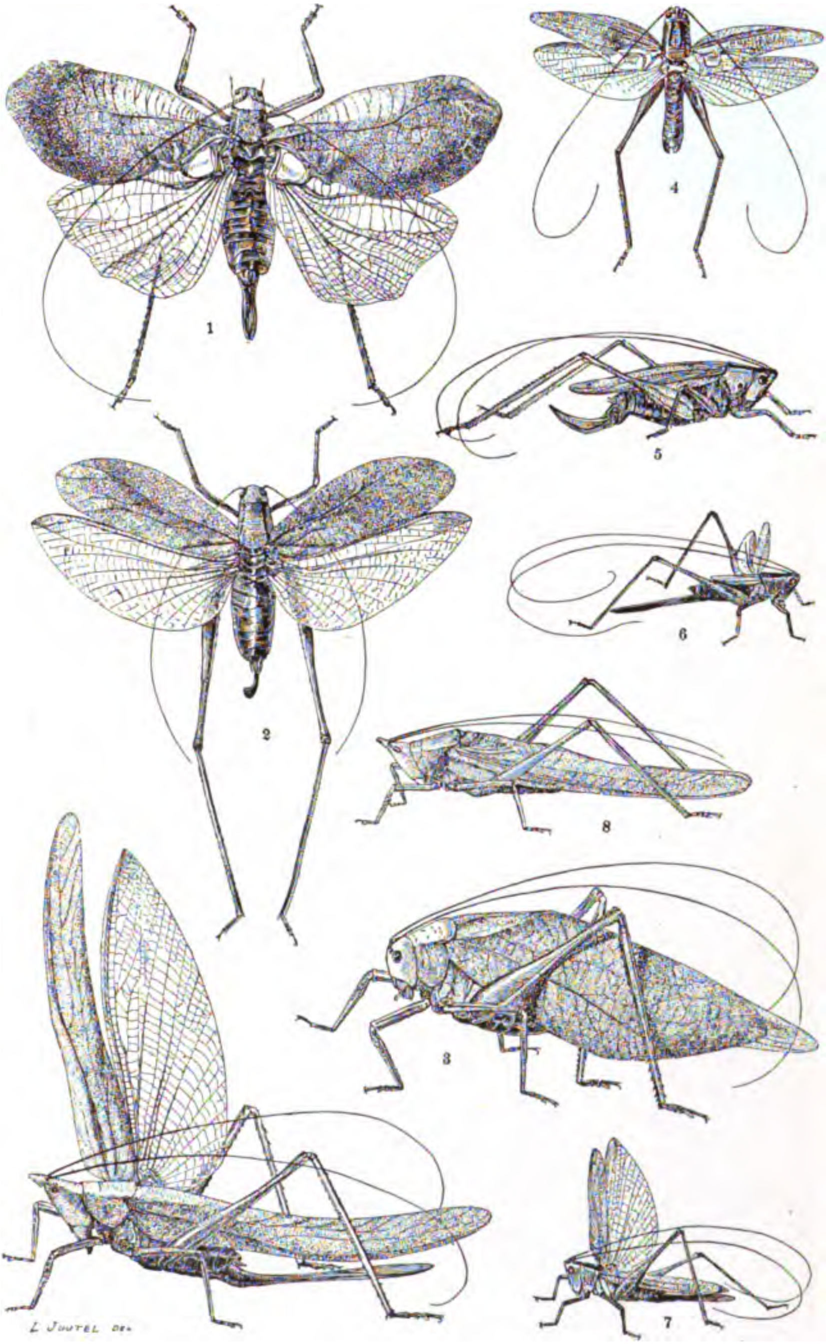


Neotoma micropus.

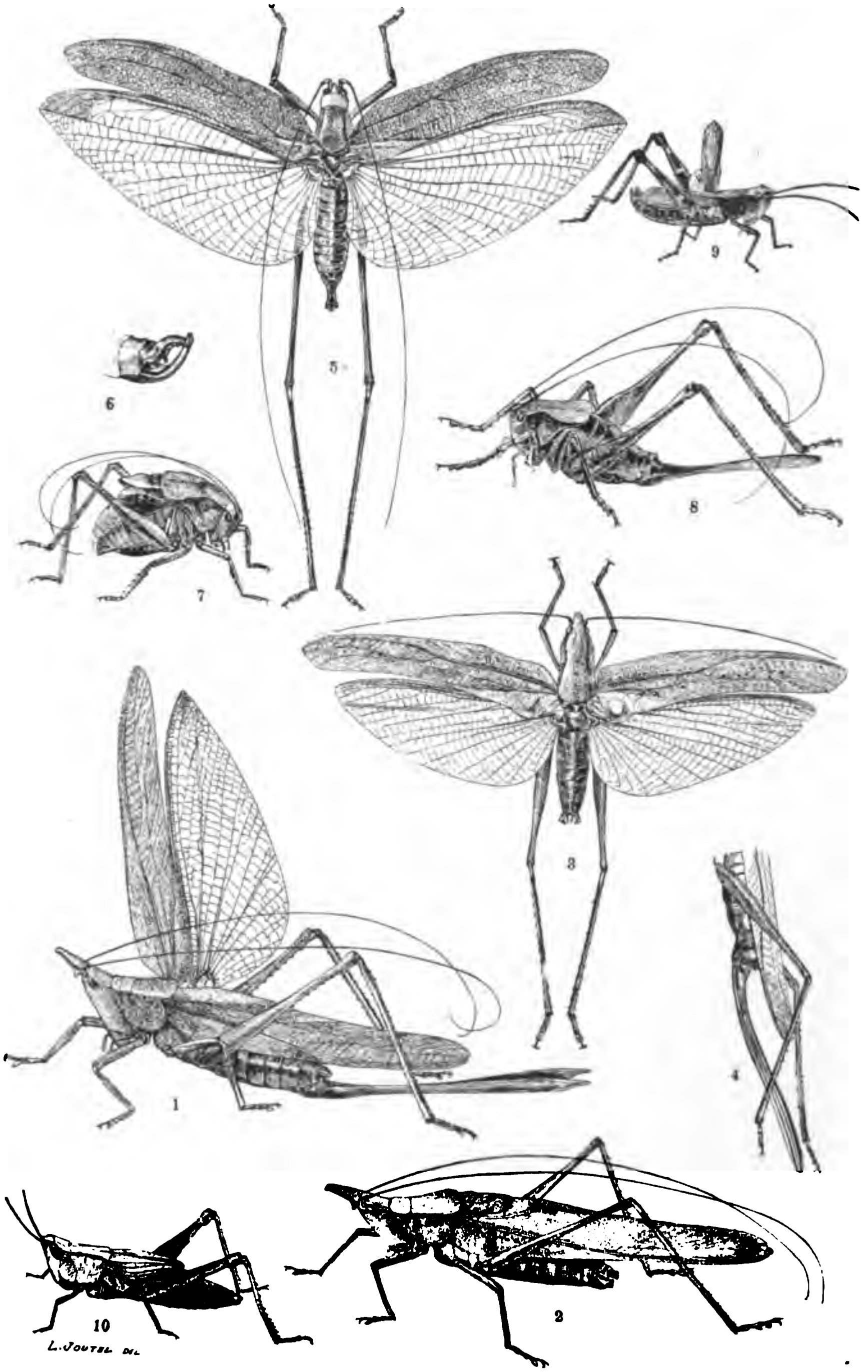
Figures nat. size.



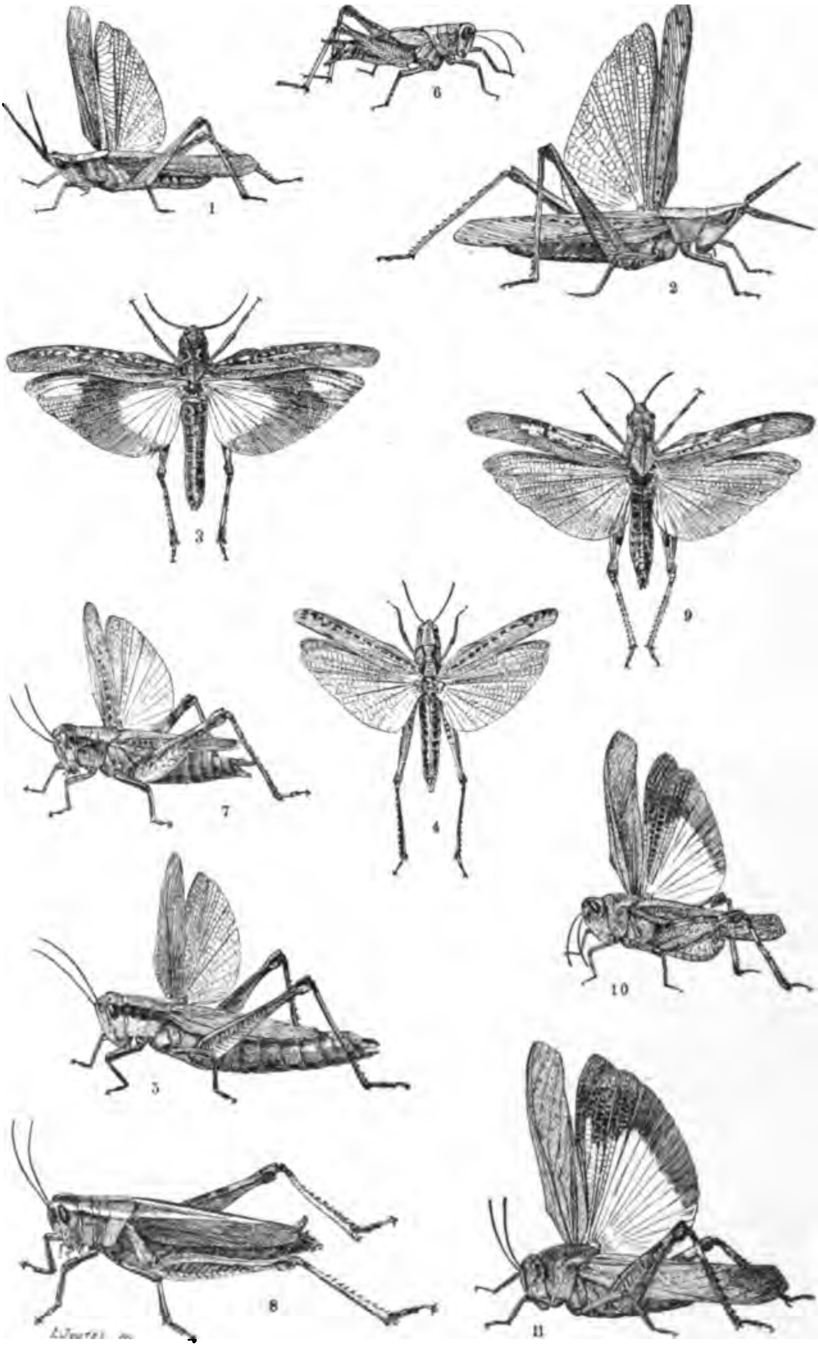
1. Anisolabis maritima.
2. Stylopyga orientalis.
3 " "
4. Periplaneta americana.
5. Gryllotalpa columbia.
6. Gryllus pennsylvanicus.
7. Gryllus pennsylvanicus
8. " domesticus.
9. Nemobius fasciatus.
10. " vittatus.
11. " affinis.
12. Œcanthus niveus.
13. Œcanthus niveus.
14. Xabea bipunctata
15. Tridactylus terminalis.
16. Phylloscirtus pulchellus.
17. Ceuthophilus grandis.



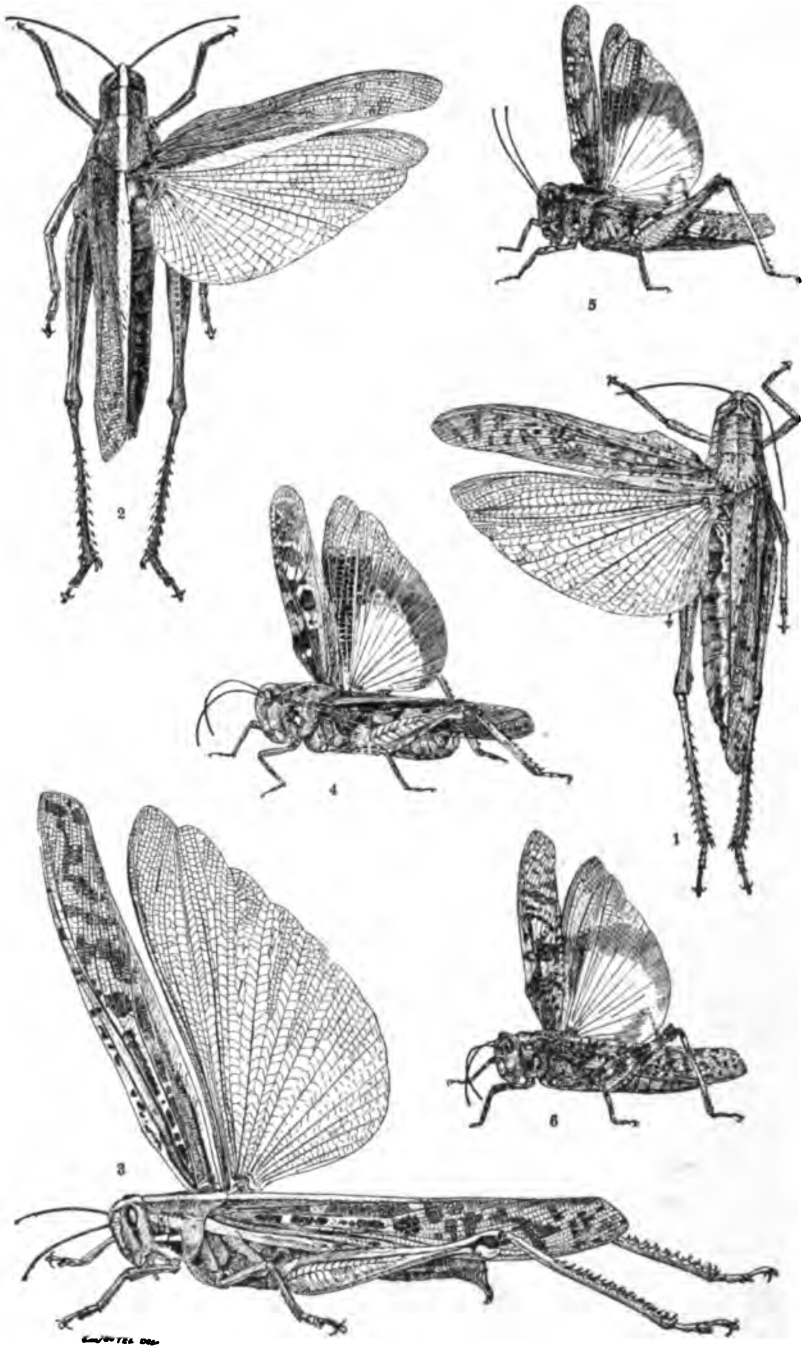
1. Cyrtophyllus concavus.
2 Amblycorypha rotundifolia.
3. Microcentrum laurifolium.
4. Orchelimum vulgare.
5. " "
6. Xiphidium brevipennis.
7. " fasciatum.
8. Conocephalus ensiger.
9. " robustus.



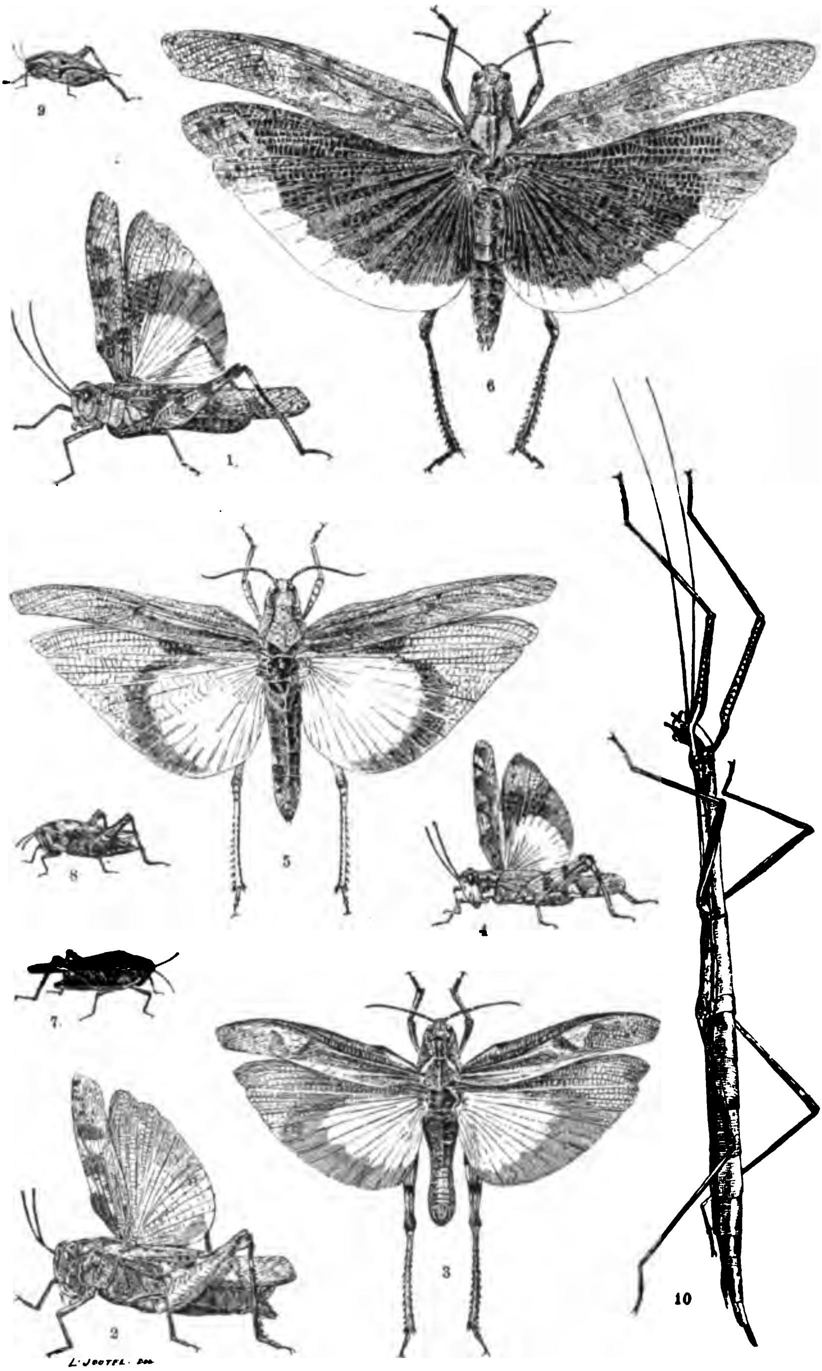
1. Conocephalus exiliscanorus.
2. " "
3. " dissimilis.
4. " "
5. Scudderia curvicauda.
6. Scudderia curvicauda, anal spines.
7. Atlanticus pachymerus.
8. " dorsalis.
9. Choealtis conspersa.
10. " viridis.



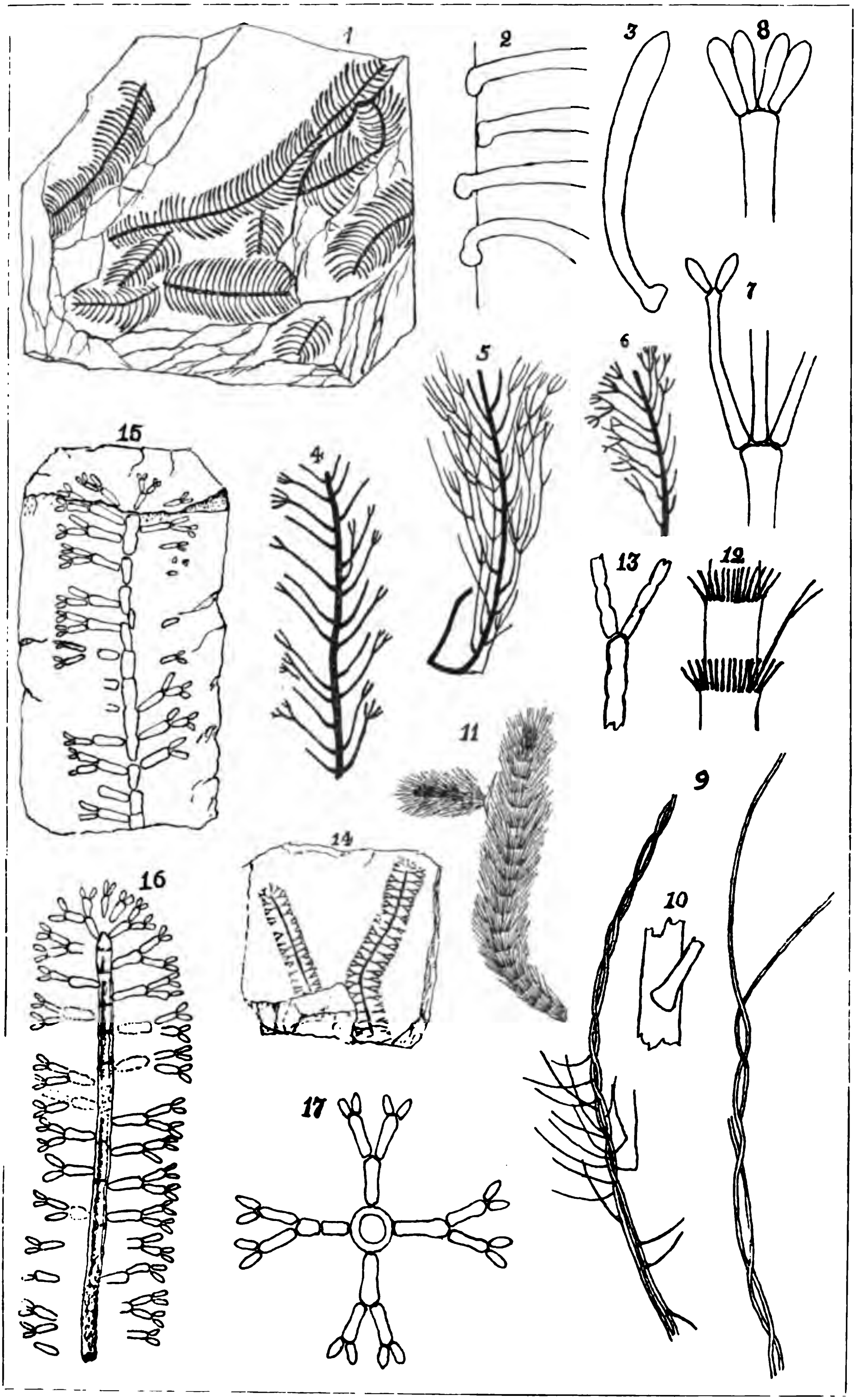
1. Truxalis brevicornis.
2. " "
3. Psinidia fenestralis.
4. Stenobothrus maculipennis.
5 Paroxya atlantica
6 Pezotettix scudderi.
7. Melanoplus femur-rubrum.
8. " bivittatus.
9. Chortophaga viridifasciata.
10. Arphia sulphurea.
11. " xanthoptera.



1. Acridium rubiginosum.
2. " alutaceum.
3. " americanum.
4. Hippiscus phoenicopterus.
5. Spharagemon æquale.
6. Circotettix verruculatus.



1. Spharagemon bollii.
2. Encoptolophus sordidus.
3. Hippiscus tuberculatus.
4. Scirtettica marmorata.
5. Trimerotropis maritima.
6. Dissosteira carolina.
7. Tettigidea lateralis.
8. " polymorpha.
9. Batrachidea cristata.
10. Diapheromera femorata.



New Forms of Fossil Marine Algæ.

BULLETIN

OF THE

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1896.

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The edition of authors' separates is 100 copies or more (frequently 150, sometimes 200 or more).

Besides the authors' separates, and in addition to the regular edition of the Bulletin, 100 copies were issued in signatures as printed, each signature bearing at the bottom of the first page the date of publication.

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BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

Volume VIII, 1896.

Article I.—THE CHANGES OF PLUMAGE IN THE DUNLIN AND SANDERLING.

By FRANK M. CHAPMAN.

One of the most interesting chapters in Gätke's notable work 'The Birds of Heligoland' is entitled 'Changes in the Colour of the Plumage of Birds without Moulting.' Herein Herr Gätke tells us that for over forty years he has given "the most unremitting attention" to this subject. As a result he presents us with three explanations of the manner in which a bird may pass from winter dress into full breeding plumage without molting. Briefly, they are the following: First, by "shedding the edges of the feathers...." Second, by "a peeling off of the separate barbs of the feathers, whereby these are stripped of a thin inconspicuously coloured envelope, so that the purer and finer colour previously concealed beneath the latter becomes exposed.......Further, the feathers, which by the end of winter were worn irregularly, and blunted at the tips, after this change of color, again have their margins completed, and their tips beautifully and evenly rounded off, so that they are in all respects like perfectly new feathers, such as would be produced by moulting." The third process is the "most wonderful," and "consists in an actual, complete, and very striking change in the colour of the feathers, without such alteration being brought about, or even assisted, by any changes in their texture." The examples cited as illustrating this change are the Little Gull, Guillemots, and Razor-billed Auk, in which the head and neck change from white or whitish to slaty black or blackish brown; the Dunlin, in which the upper belly changes from white to black, and other species.

The first explanation given by Herr Gätke is well known to occur in many species, and calls for no special remark in this connection. The second and third are, in part, original with him, and the evidence which he presents in their support is derived entirely from his own observations.

Probably owing to our comparative ignorance of the molt of birds and its attendant phenomena, these statements of Herr Gätke's have not only passed unchallenged, but have actually been endorsed as correct. Already we find that they have become part of the literature of general ornithology, and we read of the renewal of the worn tips of feathers and repigmentation as though they were established facts.

Herr Gätke describes in some detail the manner in which the changes of color previously mentioned occur. He does not, however, tell us just how his conclusions were reached, whether by the examination at one time of large series of specimens, or at intervals upon occasional specimens during the forty years which he has devoted to the subject. This, of course, is a matter of some importance, as every one who has studied the molt knows, and it seems to me that before accepting Herr Gätke's views they should be thoroughly tested by a study of series of specimens representing the species he mentions. As a contribution to this end I offer the following notes on the changes in plumage of the Dunlin (*Tringa alpina*) and Sanderling (*Calidris arenaria*), two species from which Herr Gätke obtained "surprising results."

The Dunlin may, I think, be quickly disposed of. It will be remembered that in winter plumage this bird is almost uniform brownish gray above, the breast is washed with the same color and indistinctly streaked with blackish, the throat and belly are pure white. In summer plumage the feathers of the back are black broadly margined with bright rufous, somewhat lighter terminally, while the scapulars have more or less irregular subterminal black or rufous bars.

The change from winter to summer plumage is explained by Herr Gätke as follows: "In the ash-grey feathers of the back the shaft first becomes black; this color spreads rapidly over the feather, finally leaving only broad grey margins. The latter at first change to a dull rusty grey, which, however, subsequently passes into a beautiful ferruginous color. At the same time the dull ash-grey tips of the feathers pass into a whitish grey, their margins being simultaneously rounded off to their former entirety. This shows that these feathers also, which in winter are worn in such a way as to assume a lanceolate shape, undergo a renovation of structure, and that their tips do not acquire their whitish colour simply by fading. In the Dunlin this change does not extend to the long posterior flight-feathers and the smaller outer plumage of the wings, in which the colour only becomes somewhat blacker, and the margins somewhat more even, but which do not acquire the appearance of newly developed feathers, like those of the upper parts of these birds." The change in the color of the lower belly from white to black is accomplished by the third process described by Herr Gätke, mentioned above, that is by "complete and very striking change in the colour of the feathers, without such alteration being brought about or even assisted by any changes in their texture."

Whether the gray feathers become black and rufous by a chemical change in their pigment or by repigmentation is not said, but since white feathers are said by Gadow to be pigmentless, we infer that according to Herr Gätke the Dunlin's white belly becomes black by an actual influx of pigment.

Now let us see how far his claims are borne out by the series of Dunlins before me. This consists of fifty-seven specimens, of which eleven are *Tringa alpina*, while forty-six are *Tringa alpina pacifica*. Of the whole number, twenty-seven are in fall or winter plumage, and thirty are in spring or summer plumage. It is the latter series which interests us. Of these thirty birds eighteen have apparently acquired their breeding plumage. There is of course considerable variation in their colors; some are much blacker below and more rufous above than others, in fact the differences are of just the nature we expect to find in a series of birds in breeding plumage, and are presumably dependent upon the age and physiological condition of the individual.

The remaining twelve have not completed their breeding plumage, and are in various stages of the molt. This statement so obviously affects Herr Gätke's conclusions in regard to the change in plumage in the Dunlin that it will be well to describe some of these molting specimens in detail. The dates of capture range from April 2 to May 22; the localities represented are the Atlantic, Pacific and Gulf Coasts of the United States. Am. Mus. No. 29888 (So. Car., April 13, 1883, Hoxie) is just beginning to acquire the summer plumage. It has numerous pin-feathers upon the foreneck, breast and belly, the head, hindneck, back, and scapulars. Many of these new black, or rufous and black feathers are half grown, while a few are fully grown and their unworn edges are in strong contrast to the ragged borders of the gray winter plumage. Am. Mus. No. 64970 (Long Island, April 3, 1882, Dutcher) resembles the bird just mentioned, and also has numerous pin-feathers in various stages of growth upon the foreneck, breast, belly, hindneck, back, and scapulars. Am. Mus. No. 55008 (Texas, April 25, 1891, Chapman) is more advanced, being evidently at the height of the molt, and one cannot raise the plumage of any part of the body without discovering numbers of growing new feathers wrapped in their dermal sheaths. The remaining nine molting birds simply confirm what those described show, that is, that in passing from winter to summer plumage the Dunlin undergoes a complete molt of the body feathers and scapulars, but retains its rectrices and remiges.

Turning now to the Sanderling, Herr Gätke remarks that in this species "we meet with an actual threefold change of colour in the feathers of the upper parts of the winter plumage, each one of which undergoes a transition from a uniform light grey to a deep black, and from a beautiful ferruginous colour to a pure white. The black, which forms the ground colour of the feathers of the summer plumage, at first appears above their subsequently white terminal markings, and advances with increasing intensity towards the radical portions of the feathers. Soon dull rust-coloured lateral borders are developed, side by side, with this ground colour, and a blurred spot of similar colour is formed on each web of the feathers; these spots increase in size, become purer in colour, and partially pass into transverse bands; simultaneously with these changes the dull light-grey tips of the feathers become transformed to a pure white; not, however, by mere fading, but in this case also by a restoration of the worn and blunted barbs to their previous entirety. When the change of colour is complete, the feathers are of a deep glossy black, with broad, pure white borders, and beautiful sharply defined ferruginous spots at the sides, or transverse bands of the same colour: their tips, too, which had been worn down to a lanceolate shape, have now reassumed their formal [*lege* former?] beautiful rounded form and entirety of margins. In this species the change of colour, and simultaneous restoration of the edges of the feathers, extends to the long posterior flight-feathers and outer wing-coverts."

The barred and rufous breast of the breeding bird is not described, and the breast is said to become even whiter than in winter, a statement I do not understand, but that is of no importance in this connection. I have here quoted Herr Gätke at length, because his explanation of the manner in which the Sanderling acquires its summer plumage is quite as wonderful as any statement in his chapter on 'Colour Changes.' With every desire to thoroughly and fairly test Herr Gätke's claims, I have, through Mr. Ridgway's kindness, been permitted to borrow the Sanderlings in the National Museum, and these, in connection with the specimens in the American Museum, give me a series of ninety-seven examples, representing every month in the year except July. I will therefore describe the plumage changes of this bird in some detail.

Beginning with the adult bird in full breeding plumage, the necessity for large series in studying the molt and the erroneous conclusions which may be drawn from negative evidence, is at once apparent. There is no reason to doubt that the Sanderling, like other birds, undergoes a complete molt after the breeding season, nevertheless not one of my twenty August specimens shows any signs of molt in progress in the wings or tail. In the larger number, however, the remiges and rectrices are in an apparently fresh and unworn condition, and I assume that in most cases these important feathers are acquired before the migration is begun. This would be in July, a month which, as I have said, is not represented in my series.

Growing feathers can, however, be found in numbers upon the body as the new gray plumage slowly replaces the worn one of rufous and black, and the winter plumage is completed late in September or in October.

The young bird in the down I have not seen, but the nestling plumage is followed by the well-known plumage of the immature bird in which the back is black, each feather being terminally bordered with whitish or with two terminal whitish spots. Late in the autumn these young birds molt their body feathers and acquire a gray and white plumage closely resembling the adult. This change is shown by specimens from Yucatan, Paraguay, Aldabra Island, and other localities. In winter plumage the upper parts, including the scapulars, are ashy gray, the entire under parts pure white. A specimen collected by Herr Gätke at Heligoland, January, 1879, shows that in some instances, at least, the birds of the year can be distinguished from adults as late as midwinter by the narrow black tips of the wing-coverts.

This brings us to the change from winter to breeding plumage, which Herr Gätke, as already described, asserts is accomplished without molt.

My series of twenty specimens illustrating this change show that it begins late in March or during the first half of April and is completed in May. They show, furthermore, that it is accomplished by a molt. In proof of this statement I will describe several of these molting birds. No. 3685 (Coll. Geo. B. Sennett, Corpus Christi, Texas, March 28, 1886) is to all outward appearances in the winter plumage of the adult, but examination shows that the molt is in active progress over the entire body, in the scapulars, tertials, all but the greater series of wing-coverts, the upper and under tail-coverts. One of the median pair of rectrices is about one-third grown, while its fellow is missing. Am. Mus. No. 45485 (California, April 13, Xantus) closely resembles the preceding in appearance, and like it is undergoing an active molt throughout the body and scapulars. The wing-coverts and median rectrices, however, as yet show no indications of the molt. No. 6042 (Coll. Geo. B. Sennett, Corpus Christi, Texas, April 20, 1889, Singley) is slightly more advanced than either of the birds just described. New feathers are appearing not only over the whole body, tertials, lesser and median wing-coverts, but the molt extends to the outer pair of tail-feathers, which with the median pair are about half grown. Only seven of the twelve old tail-feathers remain, and it seems probable that all the rectrices are renewed.

Am. Mus. No. 60007 (Micco, Florida, April 30, 1891; C. S. Allen) has nearly completed the molt, though new feathers are still appearing all over the body. The rectrices, tertials and lesser and median wing-coverts have apparently been renewed. Nearly all the newly-grown or growing feathers of the upper parts are broadly tipped with ashy gray, which, as numerous specimens show, is later worn off, leaving the black and rufous of the full breeding plumage.

It is evidently unnecessary to describe other specimens in this series which show the molt in every stage, and prove beyond question the manner in which the change from winter to summer plumage is accomplished.

Would that Herr Gätke's explanation of this change could be explained as easily, for in view of the large number of molting birds contained in my series of Dunlins and Sanderlings, his failure to find a single molting spring specimen is certainly a remarkable coincidence.

As further supporting my belief in the incorrectness of Herr Gätke's observations, I may add that I have examined specimens of several other species which he would have us believe acquire their breeding plumage through the same mysterious and wholly inexplicable cause to which he ascribes the changes above described in the plumages of the Dunlin and Sanderling. As a result, whenever my series has contained individuals taken at the proper season, it has clearly demonstrated that the change was accomplished by molt. Thus the Golden Plover, Knot, and other members of the order Limicolæ are shown to have a spring molt, and while I have seen no molting specimens of *Larus minutus* the Museum possesses spring examples of *Larus atricilla* in the height of the molt.

There is evidently, therefore, urgent need for a thorough revision of this remarkable chapter on 'Colour Changes without Moulting,' and so strongly do I dissent from Herr Gätke's views, I venture to assert that his claims for changes in the color and disposition of pigment, and new growth in old feathers, will be found to be entirely baseless.

Article II.—ON THE CHANGES OF PLUMAGE IN THE SNOWFLAKE (PLECTROPHENAX NIVALIS).

By Frank M. Chapman.

Although the changes of plumage in the Snowflake are in a general way well understood, they have not, I believe, been recorded in detail. The acquisition by the American Museum of a fine series of freshly plumaged birds taken in October, 1895, in Maine, by Mr. John Rowley, and numerous specimens collected in June, 1895, at Holsteinborg, Greenland, by Prof. L. L. Dyche, in connection with other specimens previously in the Museum, has led to a study of the changes of plumage in this species with results which seem of sufficient interest to warrant publication.

Snowflakes molt but once a year, after the breeding season. At this time the male acquires his well-known winter plumage, in which the upper parts are bordered with rusty, the cheeks, breast and sides being tinged with the same color. At first glance it would seem impossible for a bird in this plumage to assume the black and white breeding dress without molt, but a careful examination of even the extremes, that is September and June birds, readily shows how the change is accomplished, while with a connecting series each stage may be observed.

The breeding male, it will be remembered, has the whole head and neck, entire under parts, rump and parts of the wings and tail pure white, while the back and remaining parts of the wing and tail-feathers are jet black. Now if we examine the September bird we find that where the breeding bird is white the bases of its brown-tipped feathers are white, while where the breeding bird is black, the bases of the September bird's feathers are also black. This is especially noticeable on the back, and reference to the accompanying cut of a feather from the back of an October bird will at once show the distribution of black and brown.

It is not necessary to further describe the autumn plumage of so common a species, my object being to show how the change from this plumage to the breeding dress occurs. Briefly, it is through a gradual wearing off of the brown tips, which may be a quarter of an inch in length, whereby the black or white bases of the feathers are exposed. Further reference to the feathers from the backs of October, January, March and June birds, so clearly explains the nature of this change that added remark is almost unnecessary. Not only is the apparent color changed, but the

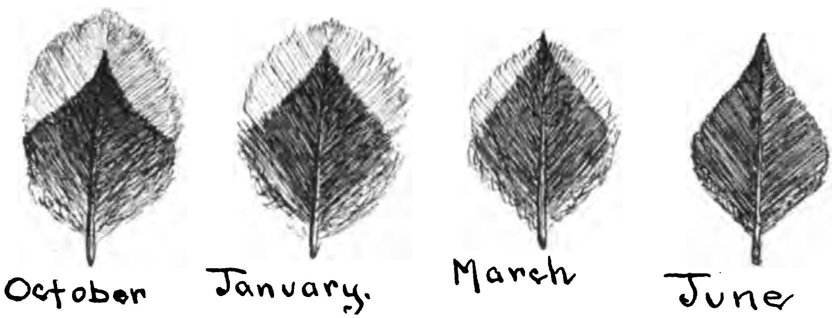

Fig. 1. Dorsal feathers of *Plectrophenax nivalis*, showing changes in form and color due to the wearing off of the tips.

shape also is altered, and in place of the rounded outline of the brown-tipped feather, we have left only its pointed, black base. The rest of the plumage undergoes a similar alteration, which in some places is evidently assisted by fading. For instance, the auriculars of September birds are brown nearly to their bases. The feathers of this region wear off only slightly, but in June birds the auriculars are pure white. There is also a fading of the brown tips themselves, and the small terminal fringe on the feathers of April birds is largely white.

The reason why these feathers in wearing off should assume a particular shape is found both in their pigment and structure. It is a well-known fact that certain pigments, doubtless in proportion to their density, give greater strength to feathers than others, and in this case that portion of the feather containing the black pigment, aside from other causes, is apparently better able to stand the effects of abrasion than the brownish or less heavily pigmented terminal portion. The strength of the black base, however, is more largely due to its structure. Examination under a low power of a dorsal feather from an October male shows that the pointed end of the black basal area extends only to the end of the true shaft, the two barbs into which the shaft divides terminally being brownish. It also shows that at their apical portion the barbs are separated, and that the barbules do not become fairly interlocked until the black basal part is reached. This will be understood by reference to the accompanying cut of

Fig. 2. Tip of a dorsal feather of *Plectrophenax nivalis*, from an October specimen. The apical portion down to the dotted line is later gradually worn off.

the tip of a dorsal feather from an October specimen. The black portion of the feather, therefore, not only is more protected than the tip, but is rendered stronger through both its pigment and structure.

Turning now to the female we find that whereas in breeding plumage she differs markedly from the male, in autumn plumage there is little apparent sexual difference. Closer examination, however, shows that the characters which so easily distinguish the female from the male in June, are also present in September, but are then largely concealed by the brownish tips to the feathers.

Thus the June female has the head, nape and rump dull blackish, not white as in the male, and when we examine September specimens we find that, aside from the difference in the wings, the sexes may be distinguished by this character; that is, the male has the feathers of the head, nape and rump basally white, while in the female they are basally black. It will also be observed that where both are black—for example, on the back—the black of the male is brighter and deeper in the autumn, just as it is in June.

But a more interesting point of difference between the sexes in breeding plumage lies in the fact that while in the male the brown tips to the feathers almost if not entirely disappear, the female retains a slight terminal fringe, which gives to her plumage a grayish cast. I cannot give a conclusive reason for this difference. There is no appreciable difference either in the length of the feather or its brownish fringe, but in the female the black center is somewhat narrower transversely, and the brownish fringe extends further down the sides of the feather, where it is evidently not so exposed. This, however, does not explain how in some feathers, for instance the tertials, the female retains a complete brownish border. The female may be less active than the male and her plumage be thus less exposed to abrasion. Still the fact remains that we have here a sexual character rendering the male more conspicuous and the female more obscure, which cannot be attributed to a fundamental sex-difference, but is made manifest through a mechanical cause.

Article III.—ALLEGED CHANGES OF COLOR IN THE FEATHERS OF BIRDS WITHOUT MOLTING.

By J. A. Allen.

As is well known, as soon as a feather has completed its growth it merely rests on the follicle which produced it; the sheath which enclosed it while growing has fallen off; the pulp which nourished it has wholly disappeared from the base of the calamus, which is now filled with a chain of dry 'caps'; the blood vessels which supplied the growing feather with nourishment have become obliterated. The perfected feather, though worn for from a few weeks to a year, according to the species and the character of the feather, is in one sense practically a dead organ, inasmuch as it is insusceptible of further growth or repair. If its edges become abraded, or the shafts or barbs become broken, they remain so till the feather falls out and is replaced by a new one. It is to this extent comparable to a perfected leaf of a tree,[1] which, while retaining vitality for months, has not the power of self-repair; if it becomes wormeaten or otherwise mutilated, so it remains till its appointed time to ripen and fall. It may, in many cases, cling to the tree during the following winter, but when spring comes and the sap again ascends, the leaf, instead of receiving the sap and again proceeding to turn green, and to replace any parts of its structure it may have lost during the former season, is loosened from its attachment and falls to the ground, giving place to such new growth as may be destined to succeed it.

The simile of the leaf and feather is thus apposite and true. Yet if we can credit the allegations of some ornithologists the simile is far from representing what actually occurs in the case of feathers, which, it has often been claimed, as will be shown in the following pages, take on new life after a long period of rest, becoming permeated by secretions, which not only transmit new coloring matter, transforming pure white feathers into jet black

[1] Since writing this I find Dr. Bachmann made the same comparison in 1839, using much the same phraseology. See his 'Observations on the Changes of Colour in Birds and Mammals,' cited later. I find the same simile was also employed by Brehm in 1853, as also noted below.

ones, but solid material for restoring the ragged edges of the abraded feathers to their original size and form—in other words, transforming, just before the breeding season, the worn, faded plumage of the winter dress to the fresh, brightly, and often wholly very differently colored dress of the nesting season.

A brief account of this delusion, for such it may be justly termed, forms a most instructive chapter in the general history of the origin and persistency of error.

The assumption that birds change the color of their plumage without undergoing a molt, to the extent even of replacing one coloration by another radically different, crops out here and there at a quite early period in the history of ornithological literature, and probably dates back as a popular belief for centuries. As first expressed by the earlier writers it was little more than a belief or an opinion, advanced with little or no attempt at proof, and obviously originated in superficial or faulty observation ; while later the strong bias of an hypothesis has often blinded the observer to the real facts and conditions of the case.

The Rev. John Fleming appears to have been the first to propose and advocate the theory that "the colours of the hair of quadrupeds, and the feathers of birds, change with the season, independent of the ordinary process of *casting and moulting*," in his article on 'Hibernation' in Brewster's 'Edinburgh Encyclopædia," published in 1817. This he further elaborated and republished in 1820,[2] to which a note is appended by Professor Jameson. In the meantime the Rev. William Whitear had published a paper on the same subject,[3] in which he announced it as also his conviction that in "some birds the full-grown feathers themselves change colour, without being replaced by new ones." This opinion, he says, was based on some recent observations he had made on several different kinds of birds; a few of these 'observations' are worth quoting to show the nature of this alleged evidence. For example: (1) He says a Mr. Youell, of Yarmouth, had sixteen young wild Mallards, confined in a small pond by netting, which "put on a great deal of the beautiful plumage of the old bird, and yet that no feathers were found

[1] "Vol. XI, 1817, —" Am. Ed., 1832, X, p. 732.

[2] On the Changes of Colour in the Feathers of Birds, independent of Moulting. Edinburgh Phil. Journ., II, 1820, pp. 271–276.

[3] Remarks on the Changes of the Plumage of Birds. Trans. Linn. Soc. London, XII, pt. 2, 1819, pp. 524–526.

floating on the water or scattered on the banks of the pond." (2) He received, he says, a young wild Mallard which had nearly assumed the plumage of the adult bird; "many of the feathers were particolored, the same individual feathers retaining in some parts the color of the bird during the first months and in the other parts exposing those of the perfect bird." (3) "A male Chaffinch killed in February had the feathers of the crown of the head bluish ash-color, except at their extremities, which were rufous-brown, apparently still retaining the colour of the young bird." (4) A Reed Bunting was examined, which, in these particulars, resembled the Chaffinch; (5) the Swiss Sandpiper, the Dunlin and the Black-headed Gull are mentioned as changing color in March. Of course, the Chaffinch and Reed Bunting were changing color without molt, simply by the wearing off of the edges of the feathers, while in the Gull and Sandpipers the birds were in reality undergoing a spring molt; in the case of the Mallards, the change was also of course due to a molt, although no loose feathers were observed.

But Professor Jameson, in his note above cited, claims priority for the discovery for Captain Cartwright,[1] who, in 1792, had something to say about the changes of plumage in Ptarmigan as observed by him in Labrador, namely, that they get in fall a large addition of white feathers, "and that the coloured feathers at the same time change to white."

Dr. Fleming propounded three "laws" on the subject of the changes of the color in the plumage of birds, namely: (1) That the change in spring is from "a light to a dark colour, and that in autumn this arrangement is reversed;" (2) that the change is "regulated by the temperature of the atmosphere;" and (3) "that these changes assist in regulating the temperature of the animals in the different seasons of the year." He says he was at first inclined to believe that many species of birds must be subject to "five or six different moultings in the course of the year," but failing to find satisfactory evidence of this he adopted the view that the seasonal change of color was a true change of color in the feather—a view, as thus practically admitted, based on belief or opinion rather than on evidence.

[1] "Journal, I, p. 278."

In 1830 George Ord[1] published "some observations" on the molting of birds, in which he says: "The object of this inquiry is to ascertain whether the opinion of Temminck, that some birds change their plumage *twice* a year, is founded in fact" (l. c., p. 293). He argues that because birds suffer in health when molting, and in spring show no evidence of ill health, but are tuneful and happy, it is evident that they do not molt. He further accepts Whitear's observations and conjectures (as noticed above) as proof of change of color without molting, and further states it as a well-known fact that in male Bobolinks, kept in aviaries, "there is no change of feathers: their colours being altogether the result of organical secretions."[2] He thereupon, by a simple process of reasoning, reaches the conclusion that no birds molt more than once a year, as expressed in the following: "Is there any physical necessity, then, for *two* moultings in the course of a year?—or even *three*, as some pretend? I know of none" (l. c., p. 297).

In 1835 William Yarrell, the celebrated English ornithologist, published a paper on the same subject,[3] which, through its somewhat more scientific aspect, carried great weight and has been often quoted as offering conclusive evidence of change of color in feathers without molting. According to this author there are three ways in which changes in color are effected, only one of which, however, calls for consideration in the present connection, namely, "by the feather itself becoming altered." The most surprising part of this 'classic' proves to be the character of the evidence upon which the alleged change of color rests. Yarrell himself admits that "it is certainly difficult to understand how this is so constantly effected in the web of the feather, where no vascularity can be shown to exist even when the part is growing: but the fact is certain;....and of this fact further proof will be adduced in the course of this paper."

His evidence may be divided into two kinds: (1) His own observations; and (2) those of other persons; the latter, so far as his paper shows, being his main reliance. First, as to the evi-

[1] Some Observations on the Moulting of Birds. Trans. Amer. Phil. Soc., III, 1830, pp. 292–299.
[2] On the spring molt of the Bobolink, see p. 44.
[3] Observations on the Laws which appear to influence the Assumption and Changes of Plumage in Birds. Trans. Zoöl. Soc. London, I, 1835, pp. 13–19. An earlier abstract appears in P. Z. S., 1833, p. 9.

dence given on his own authority. He says: "Several birds examined in April were changing the colour of some parts of their plumage from that which is peculiar to winter to that of the breeding season. Many of the old feathers obtained at the preceding autumn moult still retained the colours they had borne through the winter; others were changing; and some had entirely assumed the colours peculiar to the breeding season, bearing precisely the same tints and markings as some new spring feathers, the webs of which were but partly exposed." He cites as among the birds in which this change was noticed the "Black and Barred-tailed Godwits," and "several Golden Plovers." Of the latter he says: "On the breasts of several Golden Plovers some of the feathers were entirely white, the colour peculiar to all the feathers of that part of the bird in winter; some were entirely black, being the colour assumed at the breeding season; while others bore almost every possible proportion of well-defined black and white on the same feathers; *from which it appears that the same cause of particular colour in new feathers can also partially or entirely change the colour of old ones.*" Of the *facts* as stated above there is no question, for in the perfect breeding plumage of the Golden Plover the feathers on the sides of the breast are partly black and partly white, the amount of either black or white varying with the position of the feather in the pterylæ—a fact of which apparently Mr. Yarrell was ignorant. Yet these particolored feathers are the basis of his *inference* (italicised in the above quotation) that the white feathers of the winter plumage on the breast of the Golden Plover turn black to form the breeding dress! The 'proof' in this case is of course pure inference, based on lack of knowledge of the condition of the plumage on the Plover's breast in normal breeding condition. No other evidence is here offered, his reference to the Barred-tailed Godwits being general, and probably based on that given later in the same paper at second hand.

His next and only other personal evidence is that based on the Herring Gull. In this case "Several tertial feathers were found to have their basal halves blue-grey, the other parts mottled with brown." Two of these feathers were marked at Christmas by cutting notches in them with scissors, and "re-examined in April," after an interval of nearly four months. "The tertial feathers, which, when marked, were of two colours, were now entirely blue-grey; one was tipped with white." In the meantime this Gull, if it did as other Gulls commonly do, underwent a complete molt of all the feathers except the quills, including what are here called "tertial feathers." Now Mr. Yarrell was either mistaken in his identification of his supposed marked feathers, or he was not. The probabilities seem to favor the first alternative.

So much then for Mr. Yarrell's personal evidence, half of which is *nil*, and the other half seriously open to question. Now as to the evidence given at second hand. First are the observations of "the Rev. Mr. Whitear and Mr. Youell," previously published (Linn. Trans., XII, p. 524), which are merely referred to in general terms as "confirming" the fact of change of color in feathers. The worthlessness of these observations having already been shown, no further comment here is required.

The second-hand evidence consists further of "the notes of James Hunt,[1] one of the Keepers, made at the Gardens of the Zoölogical Society in the Regent's Park, during the seasons of 1831, 1832 and 1833, but principally in 1832." These relate to seven species, but in reference to only four do the observations bear on the points here at issue. First is the "Black-tailed Godwit, *Limosa melanura* Liesl." In this species the change was noticed as in progress on the breast as early as the 24th of February, and on the 29th of April had extended to the "scapulars, wing-coverts and tertials," completing the change. The observations were made on a live bird, which was examined "day by day," but how closely—whether it was handled and the plumage thus examined, or only at a distance—is not stated. The importance, or rather the absolute necessity, of closely examining the plumage by raising the surface of the feathers to see what is beneath, can scarcely be appreciated unless one has made a special study of the subject of molt. It is affirmed, however, that the change "is absolutely an alteration of colour, and not produced by moulting." But excellent authorities place this species in the list of those which undergo a full spring molt, by which they acquire the colors of the breeding dress.

The next species is the Ruff, the notes on which state that the head and neck acquire a new spring plumage *by molting*, "while

[1] Published also earlier, in abstract, in P. Z. S., 1833, p. 9.

the feathers on the body were not thrown off." Nevertheless, the Ruff is thoroughly well known to molt its body plumage in spring.

The next species in point is the Herring Gull, in which "the moulting....does not appear to expedite the change of colour. The new feathers have much the same hue as those that have been shed." Yet reference is made to "a constant change of colour going on in the feathers." A spring molt, it is to be noticed, is admitted.

The fourth and only other species bearing on the question is the "Laughing Gull, *Larus ridibundus* Linn." "The feathers on the head of this Gull began to change colour from white to black on the 11th of March. It was a change of colour, and not an act of moulting; no feather was shed, and the change was completed in four or five days." As it is now well known that Gulls and Terns are among the birds that undergo a general spring molt (the flight feathers excepted), and with specimens before me of this and various other species of Black-headed Gulls, taken in spring, and showing that not only is the black head acquired by the growth of new black feathers and the shedding of the old white ones, but that the whole clothing plumage is also at the same time renewed,[1] it is evident that not much credence is to be given to these notes of Mr. Hunt on the subject of change of color in birds without molting. The birds were probably not taken in hand by Mr. Hunt and systematically examined, he simply giving his impressions of what he thought was going on as he made his daily rounds as one of the keepers of the Zoölogical Gardens.

As already intimated, Yarrell's paper has by common consent taken the position of a classic on the subject of change of color in feathers, if we may judge by its frequent citation as an authoritative utterance from which there is no appeal. Yet it is somewhat surprising to find that as late as 1884 Mr. Howard Saunders, in his 'Yarrell's British Birds,' repeats Yarrell on the Golden Plover (Vol. III, p. 272) and Black-headed Gull (*ibid.*, p. 603) without any hint that his statements are erroneous. The following sentence about the Golden Plover, from the first edition

[1] There are specimens in the collection of the Museum, showing a general spring molt, of the following species: *Larus ridibundus*, *L. atricilla*, *L. franklini* and *L. philadelphia*; also of several species of *Sterna*.

of Yarrell's 'British Birds' (Vol. II, 1839–41, p. 386), is worth quoting on account of its reappearance in the fourth edition without change, the part here italicised being of special interest in the present connection: "Some new feathers, which are obtained in the spring, are black, whilst the old white feathers of winter may be seen in change to black, some of them bearing almost every possible proportion of well-defined black and white on the same feathers, *the colouring secretions having equal influence over the old as well as the new feathers.*"

In 1837, Edward Blyth, an English naturalist of standing, made the first really important contribution to the general subject, his papers[1] giving evidence of much familiarity with the questions at issue. Yet, while aware of the fact that many birds undergo a spring molt, whereby they acquire their breeding dress, he was seriously and strangely misled into the belief that old feathers also were susceptible of change of color; apparently through not sufficiently recognizing the fact that many young birds after their first spring molt still show more or less well-marked traces of immaturity. Still some of his statements are difficult of explanation on even the hypothesis of unfamiliarity with the progressive stages of change with age, as witness the following quotations from his paper: "I had previously noticed the highly interesting fact, which had long puzzled me, that, in the same specimen, it was not unusual to perceive new feathers shooting forth in abundance, simultaneously with the most complete and surprising changes of colour in those loose, and about to be shed; and, as I knew, from observation, that many species underwent their seasonal changes exclusively in the one way or in the other, it became difficult sometimes to assign to which class such specimens should be referred. A Golden Plover, for instance, that is now before me, is every where in deep moult, renewing both its upper and under plumage; while, coincidently, most of the loose old feathers of the lower parts have changed, more or less completely, from white to black, the hue of the new feathers which are growing" (l. c., p. 261).[2] Again: "But, to return

[1] On the Reconciliation of certain apparent Discrepancies observable in the Mode in which the seasonal and progressive Changes of Colour are effected in the Fur of Mammalians and Feathers of Birds; with various Observations on Moulting. Charlesworth's Mag. Nat. Hist., I, 1837, pp. 259–263, 300–311. Also, Some Remarks on the Plumage of Birds. *Ibid.*, pp. 477–481.

[2] On the Golden Plover, see *antea*, p. 17.

from this digression to the Ducks, it will be observed that, in the latter, a varying amount of change of colour in the old feathers is a most ordinary concomitant of the assumption of the mature plumage by moult ; and the formerly disputed fact, therefore, is thus demonstrably established, that, as the secretions which colour the growing feathers also tinge those which are about to be renewed, a circulation (evidently nutrimental ; for where a bird is ailing or ill-fed, the consequences soon appear in their diminished lustre) must, consequently, obtain in feathers, even to the extreme period of their remaining attached, so that the hypothesis is unsupported by evidence which ascribes the moulting of a bird to the same cause which has been erroneously supposed to bring about the fall of a leaf ; namely, that the pores through which the fluids circulate become gradually obstructed, and that it consequently dies, and falls off" (l. c., p. 262).

Thus Blyth, in predicating that old feathers about to fall, in birds undergoing a spring molt, share the secretions, and become changed in color by them, of the growing feathers by which they are surrounded, goes far beyond the later German and French writers (presently to be noticed), who claimed that old feathers in spring become freshened and recolored to form the breeding plumage.

In 1839 the well-known American naturalist, Dr. John Bachman, contributed a notable paper on the subject of molt and change of color in birds,[1] written, largely in reply to Yarrell, Fleming, Ord, and other earlier writers on the subject.[2] While not absolutely denying the possibility of change of color in feathers, he says : "If the feathers in birds, then, which have been long stationary in their growth, are capable of receiving a new set of secretions, and of assuming opposite colours, we must seek for some new law of nature not hitherto discovered" (l. c., p. 210). His memoir abounds with valuable observations on cage birds and on fresh specimens taken in South Carolina in the spring for the express purpose of determining what species do and what do not acquire the breeding dress by a spring molt ; from which it appears that most of our Sparrows, Wrens and Warblers, so far

[1] Observations on the Changes of Colour in Birds and Mammals. Trans. Am. Phil. Soc., VI, 1839, pp. 197–239.
[2] Bachman's paper was apparently written before he had seen the article by Blyth, noticed above.

as observed, and some of the Thrushes, and various species of Gulls, Ducks, Plovers and Sandpipers, undergo a spring molt.[1] It also appears that Orioles (*Icterus galbula* and *I. spurius*), Painted Buntings, and some other species, acquire changes of color when kept as cage birds only at the season of molt.

Yet change of color in feathers without molting has been independently affirmed, and even advocated with great earnestness, by many writers during the last half century, the writings of only a few of which can be noticed in the present historical review of the subject. Dr. C. W. L. Gloger makes the claim that Audubon was the first to confess belief in a change of color without molt,[2] basing the claim on the following passage in Volume IV, p. 213, of the 'Ornithological Biography:' "Since I began to study the habits of Gulls," says Audubon, "and observe their changes of plumage, whether at the approach of the love season, or in autumn, I have thought that the dark tint of their hoods was in the first instance caused by the extremities of the feathers then gradually changing from white to black or brown, without the actual renewal of the feathers themselves, as happens in some species of land birds." Several long quotations are also made from Audubon's account of the Black-headed Gull (l. c., pp. 120–123), leading to the inference that Audubon believed the breeding dress was acquired by change of color without molt; but Audubon does not so state, much less does he offer any proof that such is the case. Yet Gloger makes these quotations the basis of a long disquisition on 'Umfärbung ohne Mauser.' Although Audubon's work was not published, says Gloger, until 1838, his studies of Gulls date much earlier, and therefore some forty years before the revival of the doctrine by Schlegel and others, in 1852, as presently to be noticed. In passing, however, it may be observed that these statements of Audubon's—a mere opinion or belief—furnish a fair sample of the 'evidence' offered by Gloger and others for a change of color without molt.

The papers of Yarrell and Blyth seem not to have been known to the German and other continental writers, who, from 1852 to

[1] Dates are given as to when the specimens were taken, and also notes as to the progress of the molt in the same species at different dates.

[2] Audubon als der erste Bekenner der Ansicht von 'Umfärbung ohne Mauser.' Journ. für Orn., II, 1854, pp. 328–334.

1856, published so much on the subject in 'Naumannia' and the 'Journal für Ornithologie.' The theory started afresh with Hermann Schlegel's address before the Altenburg Congress of Naturalists, held July 6, 1852.[1] In this paper Schlegel formulates various rules or laws respecting the season, manner, degrees and methods of molt, and the changes of color without molt, which are followed by a somewhat detailed account of the observations on which they purport to be based. Some of his 'laws' prove to have been well founded, while others were based on faulty observations, as was soon made known by various commentators on Schlegel's paper. He was not, however, the first, as he supposed himself to be,[2] to formally announce that in many species the distinctive coloration of the breeding plumage may be acquired by the shedding of the edges of the feathers of the winter plumage. Among other things, he affirmed that after feathers had reached their full maturity, they may, after a longer or shorter period of rest, by a fresh influx of secretion ('Saft') be made new, even to the restoration of their ragged edges by the formation of new barbs and new barbules. The color, he distinctly states, passes into the feathers, as well as into the bill, the feet, and the naked parts of the skin, and that it is by this process only, and not by molting, that the breeding dress in most birds is acquired.[3] The process of color change, he asserts, proceeds in many cases from the root of the feather outward, as when white, yellow or brown feathers change to black, etc.

We naturally turn to the observations on which such startling announcements rest. And what do we find? The results of microscopical examinations and systematic study of living birds? Nothing of the sort; merely off-hand assertions based mainly on the inspection of museum specimens. He takes up in systematic order the leading groups of birds, beginning with the Vultures and ending with the Ducks and other water-birds, and states how they acquire their breeding plumage. For example, to give

[1] Sendschreiben an die am 6. Julius 1852 zu Altenburg versammelten Naturforscher. Naumannia, II, Heft 2, 1852, pp. 19–40.

[2] See E. von Homeyer, Rhea, II, 1846, p. 159; Naumannia, 1853, pp. 64–78; Journ. für Orn., III, 1855, p. 112; IV, 1856, p. 129.

[3] "Zu dieser Zeit tritt auch eine grössere Menge Pigment in die Federn (wie dies auch in dem Schnabel, den Füssen und den nächsten Theilen der Haut stattfindet). Durch diesen Prozess nun, und nicht durch die Mauser entsteht das vollkommene oder Prachtkleid der meisten Vögel."—Naumannia, II, Heft 2, p. 22.

a free translation: "*Cathartistes papa.* The young bird, as is known, is grayish brown-black. In this species the beautiful gray-yellow and the other colors of the old bird arise through change of color without molting. At this time appear the bright colors of the naked parts" (l. c., p. 24).

Again he says: "The origin of the breeding dress through color change (Verfärbung) I have observed in many species of the genus *Icterus.* In the following was this appearance especially striking. *Ict. icterocephalus* is yellow-gray when young with a yellow throat, black with a yellow neck and head when adult. In specimens in transition this color change is clearly seen. The black head and back of *Ict. baltimore* is wholly obtained through the change of color in the feathers without molting. *Ict. spurius* is yellowish below and green above when young, but changes to black, with reddish brown lower back, shoulders and lower belly. This color change is entirely due to change of color in the feathers without molting, the black appearing first at the base of the throat feathers, and later, like the reddish brown, spreads over the other parts" (l. c., p. 25).

Again: "In the species of *Cœreba* the change in color without molting from the greenish dress of the young to the full blue and black dress of the adult is easily seen."[1]

This is a sample of the proof offered in support of his statement that the breeding dress in most birds is acquired by a change of color in the plumage without molting! There is running comment of a similar character respecting several hundred species. The above is doubtless enough to show its utter worthlessness. He has simply looked at birds in transition stages of plumage and mistaken the intermediate phases as proof of an actual change of color without molt; whereas by means of large series of specimens, as in the cases above cited, as well as in countless others, the change from one phase to another can be traced through specimens that were actually molting when taken.

A few months later Dr. E. F. von Homeyer replied at length[2] to Schlegel's remarkable paper, premising that it contained much

[1] In the collection of this Museum are many specimens of various species of this group, taken while in molt, and showing feathers of the adult plumage in all stages of growth appearing in the immature greenish dress.

[2] Ueber den Federwechsel der Vögel; mit Rücksicht auf H. Schlegels Sendschreiben an die Ornithologen-Versammlung zu Altenburg. Naumannia, Jahrgang 1853, pp. 64-78.

that was true and much that was new, but that he had important reasons for believing that not all that was new was true, and that not all that was true was new.[1] Dr. Homeyer takes up Schlegel's ten laws or propositions seriatim, commenting on each, approving some, qualifying some and rejecting others. This is followed by critical comment on individual species, chiefly European, in rebuttal of statements by Schlegel. In the present connection we are interested mainly in Homeyer's position on the subject of change of color in feathers without molting. Such changes as Herr Schlegel claims, as from white to black, etc., he says he has never observed in any bird, and until it has been proved to take place in some particular species he shall maintain that it does not occur. He recognizes only such changes as are due to the wearing off of the edges of the feathers, and the slight changes due to exposure to light and atmospheric influences. He then proceeds to remark upon many of the commoner birds of northern Germany, which he has carefully studied in life, with special reference to the molt, correcting many of Schlegel's false statements in regard to particular species, and instancing numerous birds which acquire their breeding dress by a spring molt.

Homeyer concludes his paper by formulating his own conclusion on the general subject of molting and color change in feathers. Respecting the rejuvenation or 'Nachwachsen' of the feathers, he says that no growth takes place that is not uninterruptedly continuous from the molt. A later occurring period of growth after the maturation of the feather is beyond imagination and contrary to the whole course of nature.[2]

Dr. C. W. L. Gloger continues to believe in the change of color and in the regeneration of feathers in spring without molt. In one[3] of his several papers on the subject he says that many birds fail to acquire in the fall the full colors of their perfect plumage, the deficiency being supplied in the spring by a new influx of nourishing secretion and pigment![4] Not only this, but the abraded

[1] "Dieselbe enthält allerdings viel Richtiges und viel Neues; indessen habe ich gewichtige Gründe, weder alles Neue für richtig, noch alles Richtige für neu zu halten" (l. c., p. 65).

[2] "Ein Stillstand oder ein Absterben des Gefieders und ein später eintretendes Nachwachsen ist undenkbar, und mit dem ganzen Wesen der Natur—wo es überall keinen Stillstand gibt—im grellsten Widerspruche" (p. 77).

[3] Zur Erklärung der Verfärbung des Gefieders. Journ. für Orn., I, 1853, pp. 268–276.

[4] "Das hieran Fehlende wird im Frühjahre durch neu eintretendes Zuströmen ernahrender Säfte und färbender Stoffe nachgeholt" (p. 270).

edges of the feathers are restored by a renewal of the lost portions![1] These ideas are elaborated at length, but wholly on hypothetical grounds.

Pastor Chr. L. Brehm follows with a paper[2] in the same journal which forcibly supplements that by Homeyer already noticed, and in which he vigorously attacks Schlegel's 'Verfärbungstheorie,' and incidentally exposes the erroneous observations of Herr Leopold Martin on the change of color in the Scoter.[3] Brehm calls attention to the fact that the spring plumage is acquired in many birds through a spring molt. He considers Schlegel's belief that an old feather can increase its size and build out its broken edges as a strange assertion ; a feather being like a leaf of a tree in that when once grown it cannot alter its size or form by the addition of new substance. Also, he says, no bird can pass from the plumage of the young into that of the adult through a simple change of color without molting. Such a change he declares to be simply a physical impossibility; in support of which he offers, not speculation and theorizing, but facts derived from direct observation in the field of what birds actually do.

Later Herr Brehm returns to the subject in a paper on the relationships of the Blue-throated Warblers (genus *Cyanecula*) and their molts.[4] These species molt in northeast Africa in February and March, by which process they acquire their breeding dress, and in no way by a change of color in the feathers themselves ("keineswegs aber durch Verfärbung"). When the new feathers first appear they are dull in color, lacking the brilliancy of tint they acquire later. This is due to a gray border which soon wears off—a color change long known to him—giving place to the lustre and brilliancy of the perfect breeding dress.

Brehm later writes of the changes of plumage in the Terns,[5] based on a large series of specimens collected by his son Alfred

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[1] "Auch findet hierbei, oft sehr sichtlich, eine mehr oder weniger bedeutende Erweiterung der Federränder, mithin eine theilweise Erneuerung derselben durch Fortwachsen Statt. Ins Besondere können auf diese Weise die jüngeren Vögel ihr so genanntes erstes Herbstkleid zum nächsten Frühlinge in das vollkommene ('ausgefärbte') der älteren verwandeln" (p. 270).

[2] Gegen Schlegels Meinung über die Verfärbung des Gefieders. Journ. für Orn., I, 1853, pp. 347–351.

[3] Zur Verfärbung des Gefieders, namentlich bei *Anas nigra* [*Oidemia nigra*]. Journ. für Orn., I, 1853, p. 208.

[4] Zur Sippe der Blaukehlchen (*Cyanecula*) und deren Mauser. Journ. für Orn., II, 1854, pp. 33–36.

[5] Verfärbung und Federwechsel der europäischen Seeschwalben. Journ. für Orn., II, 1854, pp. 317–321.

in Africa. He traces the changes from the first or nestling plumage to the adult, showing how and when the various stages are acquired, and that each stage or change of plumage is due to molting and never to color change in the feathers themselves. After a review of the facts in the case, as shown by his specimens, he states that there is no room for doubt that Schlegel's 'Verfärbungstheorie' is entirely groundless.

Another contemporaneous contributor to this lively discussion is A. Hessler, who writes on the changes of color in various tropical and other Finches,[1] as observed by him for many years in confinement, in opposition to Dr. Schlegel's theory that the full breeding dress of the males is due partly to a change in the form—through a later aftergrowth (Nachwachsen)—and partly to a change of color in the feather itself without molting. While in these birds the color may be heightened by the well-known process of the wearing off of the edges of the feathers, the long tail feathers of certain of the species can be produced only by molting.

Herr Böck writes of the changes of plumage in the Ducks and Loons, with particular reference to the Scoter,[2] in correction of Herr Martin, and against Schlegel's theory. He had had before him large numbers of specimens taken in spring in which the fresh new feathers were coming in *en masse* without meeting with a single example showing color change in progress without molt.

Of special interest in this connection is a paper by Herr H. Gätke,[3] in which he claims to substantiate Schlegel's theory by numberless direct observations from nature, and in which he here sets forth all the wonderful things one finds in his chapter on 'Farbenwechsel der Vögel durch Umfärbung ohne Mauser' in his 'Die Vogelwarte Helgoland,'[4] published in 1892. Although he speaks in praise of Schlegel's paper in general, he differs from many of his conclusions, considering it as incomprehensible that Schlegel should attribute the change of color of the Snowbunting and some other species in spring to 'Verfärben,' instead of to the wearing away of the edges of the feathers. This method of change,

[1] Federwechsel und Farbenänderung bei tropischen und subtropischen Finken-Arten. *Ibid.*, pp. 185–187.
[2] Die Mauser von *Platypus niger* [*Oidemia nigra*]. *Ibid.*, pp. 309–311.
[3] Einige Beobachtungen über Farbenwechsel durch Umfärbung ohne Mauser. *Ibid.*, pp. 321–327.
[4] See English translation, pp. 149–164.

however, in Herr Gätke's opinion, is exceptional. In the case of *Motacilla lugubris*, of which he had had in hand hundreds of specimens in all stages of change from the winter to the breeding dress, he had never been able to find a new or half-grown incoming feather, the change being entirely due to color change without molting. Indeed, not only is there change of color in the old feathers, but a change of texture and form as well! Many of the back feathers become softer, weaker and more silky looking, and, what is more surprising, he says, the feathers become again whole-edged—that is, the barbs which had become more or less broken at the tip are again restored, so that the feather presents a regular unbroken border similar to that of a newly-grown feather in the fall.[1] This restoration extends also to the posterior wing feathers and wing-coverts. He says he was very much surprised to see this, but would not, with Schlegel, call it an aftergrowth ('Nachwaschen'). He also believes the barbs undergo a sort of scaling off process by which some parts become weaker and thinner or more silky, while, through the removal of the outer surface ('Haut oder Schale'), the color of the summer dress, which has been thus concealed during the winter, becomes perfectly exposed.[2]

He states further that he has found that changes in the external appearance of birds occur in many different ways, not only in different genera or species, but on different parts of the body of the same individual bird. He cites in illustration different examples of *Motacilla lugubris* and *Anthus littoralis*.

But in the case of *Charadrius auratus*, he says, Herr Schlegel is again wholly in error, for, instead of changing color without molting, they get their black breasts and yellow-spotted backs through change of feathers. But while he had found in spring these birds having on the breast and back the old bleached feathers of the winter plumage mixed with the more or less grown

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[1] "Und, was wohl nicht weniger überraschend ist: diese Federn werden auch wieder *ganzrandig;* d. h. die Federstrahlen, von welchen die Spitzen mehr oder weniger abgenutzt (verstossen, abgebrochen) sind, werden wieder ausgeglichen: so, dass die Spitzen aller Strahlen wieder eine regelmässige, ununterbrochene Rundung der Federspitze bilden, ähnlich, wie die im Herbste neu gewachsene Feder sie zeigte" (p. 323).

[2] "Vielmehr glaube ich, dass dieselbe auf gerade entgegengesetztem Wege bewirkt wird; nämlich dadurch, dass in solchen Fällen, wo ausser der Farbe auch die Textur verändert wird, die einzelnen Federstrahlen ('Baarten') einer Art von Schälung unterliegen, durch welche sie eines Theiles schwächer oder dünner werden und das mehr seidenartige Ansehen erhalten: während anderen Theiles durch Entfernen der äusseren, die Färbung des Winterkleides gebenden Haut oder Schale die, schon seit Vollendung der Herbstmauser fertig darunter verhüllt gelegene Färbung des Sommerkleides sichtbar wird" (pp. 323, 324).

new feathers of the incoming summer dress, with no feathers showing change of color, he still believes that the feathers of the throat and sides of the head acquire their black color through an actual change of color without molting! In regard to *Podiceps minor*, and as he believes, in regard to many other genera, he finds Schlegel likewise in error, as he had had fresh spring specimens which were thickly clothed with still growing feathers. But in the case of *Larus minutus*, on the other hand, he had found the change from the winter to the summer dress due entirely to color change without molting. At first he could not believe it possible that the pure white feathers of the head could through simple change of color become deep black, but later he had the good fortune to receive specimens that completely disclosed the secret: in one the head was already black; the others showed the change just beginning. His account of how the change occurs deserves to be here given in his own words as one of the curiosities of ornithological literature.[1] To summarize, he says, in effect, that the winter white and gray head of *Larus minutus* changes to the black head of the summer dress wholly by a change of color in the feathers themselves without molting. The change begins in January, when there are already gray feathers on the hind head. These darken, simultaneously and little by little, becoming first dark gray, darkest along the shaft, and later clear black. At the same time the darkening extends forward on to the front of the head. Scattered feathers are at first blackish only along the apical half of the shaft, from which the color extends till the whole front half of the feather is gray; which then, little by little, turns to black, the edges of the feather changing last. But the change from the clear white feathers of the lower side of the head and throat proceeds differently, becoming black at once without passing through gray;

[1] "Der im Winter weiss und hellgrau gefärbte Kopf von *Larus minutus* verwandelt sich durch *Umfärben, ohne Mauser*, in den reinschwarzen des Sommerkleides. Die Umfärbung beginnt schon in Januar, und zwar an den, bereits grau gefärbten Federn des Hinterkopfes zuerst. Dieselben verdunkeln sich, gleichzeitig fortschreitend, nach und nach alle; sie werden zuerst schwarzgrau, an den Schäften am dunkelsten, und späterhin rein schwarz. Von dem grauen Scheitel erstreckt sich das Dunkelwerden zu gleicher Zeit auf den weissen Vorderkopf. Zerstreute Federn desselben werden Anfangs nur an der Spitzenhälfte des Schaftes schwärzlich. Von hier ausgehend, färbt sich die vordere Federhälfte erst grau; dieses Colorit verdunkelt sich nach und nach, und wird sodann völlig schwarz: am spätesten an den Seitenrändern der Federn.—Ganz anders geht aber die Umfärbung der rein weissen Federn an der Unterseite des Kopfes und der Kehle vor sich. An diesen Theilen tritt nämlich *sogleich*, *ohne* einem *Uebergang durch Grau*, die rein schwarze Farbe auf: und zwar an den *Spitzen* der Federn zuerst, als ganz feiner Saum. Dieser geht bald in ein halbmondförmiges Endfleckchen über, welches, sich wurzelwärts vergrössernd, nach und nach die ganze Feder mit Schwarz bedeckt" (pp. 326, 327).

the black begins at the tip of the feather first, as a lunate terminal spot, which extends gradually towards the root of the feather, until the whole feather becomes black. The change begins at the lower border of the hood and extends upward toward the bill till the change is completed, the chin feathers being the last to turn black.

With our present knowledge that the change of color is produced by a spring molt, and that not only the feathers of the hood are molted in spring, but also the whole clothing plumage, such a description as the above seems simply incomprehensible. It certainly indicates the untrustworthy character of Herr Gätke's investigations where even merely a simple matter of observation, or alleged observation, from specimens is concerned, to say nothing of more abstruse matters, where much is necessarily open to uncertainty, as for example, the varied phenomena of bird migration.

Gätke's remarkable paper did not pass unnoticed by other investigators, sharing with Schlegel's much unfavorable criticism at the hands of several subsequent contributors to the discussion. Dr. Eugen von Homeyer returns to the subject[1] in the January, 1855, issue of the 'Journal für Ornithologie.' The same volume also contains a very important paper by W. Meves[2] on color changes in birds through and without molting, in which he gives the results of his investigations on the changes of color in Swedish birds, with special reference to Schlegel's theories upon the subject. He considers first the general question of molt, and then that of color change without molt, and finally, in a supplemental note, expresses his dissent to some of Gätke's remarkable statements.

Meves recognizes: 1. A single complete molt—the fall molt, common to all birds towards autumn, whereby all of the wing and tail feathers, as well as all of the clothing feathers, are renewed. Under this heading he gives a list of the genera and species which have only this single complete annual molt. This table includes nearly all of the Fringillidæ, the Alaudidæ, Corvidæ, Kinglets, Wrens, Titmice, Nuthatches, Swallows, Shrikes, Woodpeckers, Cuckoos,

[1] Ein ferneres Wort über das Ausfärben. Journ. für Orn., III, 1855, pp. 113–117. See also, Noch ein Wort über die Verfärbung. *Ibid.*, IV, 1856, pp. 129–132.

[2] Ueber die Farbenveränderung der Vögel durch und ohne Mauser. *Ibid.*, III, 1855, pp. 230–238, pll. ii, iii. Translated, with additions, from the Oeversigt of K. Vetenskaps. Akad. Förhandl., 1854, No. 8.

Swifts, Birds of Prey, Pigeons, Herons, Rails and Gallinules, some Grouse, some Ducks, and some Grallæ. Among the song birds not already named are many species of the genera *Sylvia*, *Saxicola* and *Muscicapa*, while some of their congeners[1] fall into the next category, namely:

2. A 'double,' second, or spring molt. This is distinguished as: (*A*) complete, including all or nearly all of the clothing feathers, and sometimes the last four wing feathers and the two middle tail feathers; and (*B*) partial; that is, only some of the feathers of the head and neck.

As this table has special bearing on what has been quoted above from Schlegel, Martin and Gætke, I transcribe in full the list, given under 2, *A*, of the birds that he has found to molt in spring.

Anthi.	Coracias garrulus.	Lestrides.
Motacillæ.	Merops apiaster.	Procellariæ.
Saxicola rubetra.	Tringæ.	Colymbus rufogularis.
Sylvia nisoria.	Phalaropodes.	Totani.
Sylvia cinerea.	Hæmatopus.	Limosæ.
Sylvia curruca.	Charadrii.	Strepsilas.
Sylvia hortensis.	Anas glacialis.	Uriæ.
Muscicapa collaris.	Sternæ.	Mormon.
Muscicapa atricapilla.	Lari.	Alcæ.

Under 2, *B*, or in the division having only a partial spring molt, he places *Sylvia suecica*, *Emberiza nivalis*, *E lapponica* and *Vanellus cristatus*, and also a large number of young males, especially Linne's Passeres, in the first spring following their birth year.

3. The summer molt, after the pairing season. This again is divided into *A*, complete, and *B*, partial. The *A* section is restricted almost entirely to the Anatidæ, which molt the body feathers and sometimes part of the wing and tail feathers, by means of which the males and females assume a more or less similar dress. The *B* section includes various species of Grouse which molt the feathers of the head and neck.

[1] It appears to frequently happen that closely allied species differ in respect to whether or not they undergo a spring molt. Thus in the Charadriidæ, judging by the abundant material in the American Museum, while apparently all the species of *Chardrius* proper, and of such allied genera as *Arenarius*, *Squatarola*, etc., acquire their breeding dress by a spring molt, the more uniformly colored species of *Ægialitis* show no indications of a spring molt. Again, while the Phalaropes, the Curlews, and many of the Sandpipers molt in spring, in the Pectoral and Bartramian Sandpipers, and in some other species, large series of spring specimens give no evidence of molt.

4. A threefold ('dreidoppelte') molt, or a union of the spring, summer and fall molts. This is also divided into *A* complete, as in *Lagopus alpina* and *L. subalpina*, and *B* partial, as in the Grebes and Cormorants.

In addition to the changes of plumage produced by molt and the growth of new feathers, Meves distinguishes changes of color due to the wearing away of the edges of the feathers. This he has found, by microscopical examination, is produced in two ways—(1) through a simple falling off of the tips of the barbs; (2) through a falling off of not only the tips of the barbs, but of the barbules as well. In the first case the coloring matter in the clothing feathers of the winter plumage which have white, dark, or colorless edges, is found in the barbules and barbs; in the second case only in the barbs. These fugaceous tips begin to fall gradually soon after the fall molt, but only in spring or later do they wholly disappear and reveal the previously concealed color in its full beauty.

In order to show the very different structure of feathers of the winter and summer plumage in some birds which have a double molt, he gives numerous figures, which he hopes will have some influence against the views of Schlegel and others who believe that one plumage can be transformed into another without molt.

In 1856 Dr. D. F. Weinland published two short papers on the subject of change of color in feathers without molting.[1] They are of interest mainly from the historic point of view, since they contain an original suggestion that later met with some favor. He accepts as a fact, to begin with, the change of color in feathers claimed by Schlegel and his followers, and considers the question, "how can a feather change its color, when its blood-vessels and nerves are dried and dead, as is the case with every feather soon after it has reached its full growth" (Proc. Boston Soc. Nat. Hist., VI, p. 35). He refers to the bleaching of specimens in museums, and to the fact that some birds, as the Merganser (*Mergus merganser*), soon lose after death the rosy tinge which in life pervades the plumage of the breast. He states that on examining a feather thus colored, taken from a freshly-killed bird, under a high

[1] Zur Verfärbung der Vogelfeder ohne Mauserung. Journ. für Orn., IV, 1856, pp. 125-129. The Cause of the change of Color in the feathers of Birds, and in the hairs of Mammalia, and the manner in which this change is effected. Proc. Boston Soc. Nat. Hist., VI, 1856-59, pp. 34-37.

power of the microscope, he "found all the pinnulæ filled in spots with *lacunes* of a reddish fluid, which....seemed to be of an oily character." Some weeks afterwards the same feathers, having been exposed to light, had become nearly white, and "instead of the reddish *lacunes*, only air-bubbles, which it is known produce a white color," were found. The evaporation of this reddish fluid, and its replacement with air-bubbles, he concluded produced the change of color. After rejecting as "unphysiological" the well-known fact that change of color is often produced by the wearing away of the edges of the feathers, he proceeds to formulate the following hypothesis, to account not only for the change of color in birds in acquiring the breeding dress, but also the changing to white in winter of many northern mammals and birds, and the sudden change to gray or white of the hair in man and the mammalia, or the feathers in birds: "If this fluid is an oily matter, as there is reason to suppose, it will be readily admitted, physiologically, that it may be furnished by the organism, by imbibition through the tissues, in consequence of a certain disposition of the nerves leading to the skin, (even if the vessels and the nerve in the feather itself should be dried,) for fat goes through all tissues without resistance, and also through horn. Thus the fat coloring matter may flow into the feathers during the time of reproduction, which is the richest season in every living organism; and then again, from want of food, cold temperature, weakness, decrepitude, or from strong emotions of the central nervous system, from sudden terror or grief,—the same coloring fat may be called back to furnish the suffering organism" (l. c., p. 36). The same hypothesis is stated, but in less detail, in his paper in the 'Journal für Ornithologie' (l. c.), which, however, in other respects is a quite different paper, dealing somewhat at length with the probable or supposed influence of climate upon seasonal change of color in mammals and birds.

As will be seen later, the idea underlying Weinland's hypothesis was subsequently elaborated in great detail as an original theory by Victor Fatio.

In 1863 N. Severtzof published a paper which, from its title,[1]

[1] Mikroskopische Untersuchungen über die Verfärbung der Federn zum Hochzeitskleide bei einigen Vögeln, nebst Betrachtungen über das Verhältniss derselben zur Mauser. Bull. de l'Acad. Imp. des Sci. de St. Pétersbourg, VII, 1863, pp. 330–346.

one would naturally expect to contain most important information. It proves, however, quite otherwise, consisting of hypothetical explanations of well-known phenomena. He makes few direct references to the literature of the subject, beyond an allusion in general terms to Schlegel, whom he calls the first discoverer of 'Verfärbung.' He states, however, that so far as he had read, no one had previously made use of the microscope in such investigations[1]—an omission he proposes to supply. He bases his investigations primarily on a series of spring specimens of *Vanellus gregarius* (=*Chettusia gregaria*) taken on the Ural River. This series consisted of birds in various stages of transition from the winter to the breeding plumage, which seemed to him to 'point to' color change in the old feathers. Examination under the microscope of a much variegated specimen, taken in April, and showing every stage of color change, convinced him that 'Verfärbung' was indeed an actual fact, although in the feather itself no vital process was taking place, the phenomenon being purely physical, and such as may occur even in a dead feather so long as it is attached to the skin, or indeed in a stuffed cabinet specimen.[2] This physical process is simply endosmosis.[3]

The *modus operandi* of the process is thus explained. He conceives first the existence of a coloring fluid, which enters the feather from the body. From the general context it would seem that he supposes the fluid to be part of the natural juices of the body, but near the close of the paper (as will be noticed later) he states that the pigment is set free from the blood, but in what way it becomes separated he fails to clearly state. At all events, under his hypothesis there is a supply of this colored secretion somewhere in the tissues of the body at the base of the feather, and this colored fluid, at the time when the dry dead feathers ('die schon trockene und abgestorbene Feder') of the autumn plumage are to be transformed into the fresh brightly colored breeding dress, it enters by endosmosis through the base of the feather and ascends, by the laws of capillarity, between the walls

[1] He must have overlooked Meves's important paper, published, as noted above, in 1854.

[2] "Ich untersuchte dieselben unter dem Mikroskop: es ergab sich, das die Verfärbung wirklich stattfindet, dass aber in der Feder selbst kein Lebens-, sondern ein rein physikalischer Process vor sich geht, der also auch an der abgestorbenen Feder möglich ist, so lange sie an der Haut haftet (was jedoch nicht unbedingt nöthig ist)" (l. c., pp. 331, 332).

[3] "Meine Beobachtungen umfassen drei Arten von Verfärbung, denen derselbe physische Process, die Endosmose, zu Grunde leigt: (1) normale Frühlingsverfärbung der lebenden Vögel; (2) anomale Sommerverfärbung derselben; (3) Verfärbung der todten Bälge. Diese drei Arten der Verfärbung erklären sich gegenseitig" (l. c., p. 332).

of the quill and the 'medulla,' reaching the vanes and passing on from cell to cell through the barbs and barbules to their extremities,[1] and even sometimes exuding from their broken tips. In this way the old feather is rejuvenated, taking on all the freshness of a newly-grown feather.[2] As this fluid dries the new pigment is deposited in successive layers on the cell walls within the feather. In the feathers of the lower body the drying is less complete than in those of the head ; in the former this coloring fluid is merely concentrated by evaporation to about the consistency of a saturated solution of gum. The drying is gradual, and is not completed till the process of color change is fully ended.[3] He admits that it is not quite clear to him how in mottled and particolored feathers the pigments are able to arrange themselves so as to form the different patterns of color-marking, but he believes it is due to bleaching and abrasion, and is conditional upon the structural differences that characterize different parts of the feather.

In regard to the origin of this color-bearing fluid, his explanation is brief and unsatisfactory. He reiterates near the close of his paper the statement that the color change in a feather is a purely physical and not a vital process. But in the skin, which is not dead, the process is vital, and is similar in character, and only differs in degree, from the formation of new feathers. The pigments set loose in the 'blood plasma' are in some way separated and enter the feathers in the manner already described.[4]

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[1] "Die Färbende Flüssigkeit dringt endosmotisch durch die Federbasis und steigt, nach den Gesetzen der Capillarität, zwischen den Wänden der Federröhre und der Medulla auf" (l. c., p. 333).

[2] "Unter den Mikroskop ist noch etwas zu sehen, was die Richtigkeit meiner Erklärung beweist: Pigmentausschwitzungen an den Spitzen der abgeriebenen Barbillen und verstossenen Federbärte. Eben diese Ausschwitzungen verursachen die Erscheinung, dass die verfärbte Feder dem blossen Auge wieder eben so frisch erscheint, wie eine neugewachsene" (l. c., pp. 334, 335).

[3] "Diese Flüssigkeit trocknet im Gefieder des Leibes nach und nach schichtweise auf der inneren Seite der Zellenwände; aber es sind viele Schichten nöthig, um jede Zelle, also auch die ganze Feder, vollständig zu färben.... Auch ist das schichtweise Trocknen der färbenden Flüssigkeit in den Zellen der Unterleibsfedern nicht als vollständiges Trocknen zu verstehen, sondern als Concentration durch Verdampfen etwa bis zur Consistenz einer gesättigten Gummilösung. Vollständig trocknet die Feder im Frühjahr erst nach geschlossenem Verfärbungsprocesse" (l. c., pp. 334, 335).

[4] "Kehren wir nun zur Verfärbung durch Saftzufluss zurück. Diese Verfärbung der Feder ist, wie gesagt, eine rein physikalische, keine Lebenserscheinung. Aber in der Haut, die nicht abstirbt, ist dieser Saftzufluss eine Lebenserscheinung, dieselbe Erscheinung, welche, nur in stärkerem Grade, auch bei der eigentlichen Mauser vorkommt. Bei einem schwächeren Saftzuflusse findet Abscheidung von Pigment statt,welches wohl im Blutplasma aufgelöst war und in der beschriebenen Weise in die shon vorhandenen Federn dringt. Bei einem stärkeren Saftzuflusse ist Neubildung von Federn bedingt, welche die alten verdrängen (normal), oder zwischen ihnen wachsen (Halskrausen des Kampfhahns und des Kragentrappen). Den Uebergang beider Processe in einander habe ich, wie gesagt, bei *Limosa melanura* beobachtet, so dass irhe wesentliche Einheit nicht bloss eine theoretische und abstracte, sondern eine concrete, thatsächlische ist" (l. c., p. 345).

That he is here grossly in error from a physiological standpoint need not be urged. His statement of the similarity of origin of his supposed coloring fluid, which enters the feather by a "purely physical process," with the formation of a new feather, is too obviously absurd for serious consideration.

It is unnecessary to follow his elaborate descriptions of the various alleged steps in the process of color change in the feathers ; suffice it to say that they are as detailed and similar in character to those given by Gätke for the Sanderling and other species, and doubtless have scarcely more basis in fact. As already said, his investigations are based primarily on *Vanellus gregarius*, but include also *Limosa rufa*, *L. melanura*, *Tringa subarquata*, *T. variabilis*, *Numenius arquata*, and *Fuligula rufina*—all species that are known to acquire their breeding dress by a spring molt. In the genus *Limosa*, however, the spring molt is often only partial, many of the feathers of the winter dress being retained, while others are replaced by new ones.

In 1866 Victor Fatio published an extended memoir[1] on the structure and coloration of feathers, reviewing briefly the work of previous writers in the light of his own investigations. He treats the subject under five headings, as follows: I. De la structure des plumes (pp. 251–261); II. Des mues réelles ou par renouvellement (pp. 261–265); III. Coloration et mue ruptile (pp. 265–282); IV. Développments parallèles des plumes et des couleurs (pp. 282–298); V. De la décoloration (pp. 298–305). His paper calls for notice here mainly on account of his peculiar views on the manner in which changes of color occur in feathers without molt. He very truly says at the outset that when the feather has completed its growth it has received all the coloring matter it can ever obtain from the body. The blood-vessels then become obliterated, the creative lymph gradually disappears, the inferior umbilicus is closed by an operculum, the now useless sheath falls away in little flakes, and the pulp which constituted the life of the feather dries up from the summit to the base. The feather having completed its development falls into a state of apparent death, receiving nothing more directly from the

[1] Des diverses modifications dans les Forms et la Coloration des Plumes. Mém. de la Soc. de Phys. et d'Hist. Nat. de Genéve, XVIII, Pt. 2°, 1866, pp. 249–308, pl. i–iii.

body.[1] Through exposure for a greater or less length of time to external influences, it progressively deteriorates, and later falls, pushed out by the new feather which comes to replace it. A feather once dry receives no longer any blood or pigment from the body.[2]

Yet Fatio admits an almost constant change in the color of the mature feathers, and it is of interest to examine what he says of how it is brought about, and his evidence of the existence of such change. The changes, he says, may be effected gradually with the advance of autumn, or, with the approach of spring, declare themselves much more rapidly. The first, he says, is illustrated in the Starling and in some Finches; the second, frequently so sudden, is seen in the new coloration of some parts of the plumage of certain birds, as in the hood of *Larus ridibundus!* And here comes to light again the old case published by Yarrell—already noticed at length in this paper—which seems to have instigated Fatio's whole assumption of a radical and rapid change of color in feathers.[3] As already shown, he disagrees radically with Schlegel, who, he says, "n'émettait qu'une pure hypothèse" when he explained the change of color at the approach of the breeding season by a renewal of life in the feather, with the transmission into it of blood and pigment. But Fatio appears to have emitted an equally pure hypothesis to account for supposed changes of color in feathers, for many of the phenomena he attempts to explain are purely imaginary, as especially those in Chapter V, 'De la décoloration.' Believing strongly in a change of color in feathers, and also that they are practically dead organs capable of receiving nothing from the body after they have matured, he conceived the idea that fat, derived from the bird's body, penetrates the structure of the feather and acts as a solvent for the pigment con-

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[1] "Plus tard les vaisseaux sanguins se sont oblitérés, la lymphe créatrice qui a subsisté encore quelques temps a disparu petit à petit, l'ombilic inférieur s'est couvert d'un opercule, la gaîne inutile est tombée par feuillets jusqu'au niveau de la peau, et nous voyons alors que la pulpe constituant l'âme de la plume s'est peu à peu desséchée, du sommet à la base, mais d'une manière plus ou moins complète suivant les différentes plumes. La plume qui a fini son développment est tombée dans un état de mort apparente, et, quoique bien souvent elle ne reçoive plus rien directement du corps, nous verrons qu'elle n'en est pourtant pas complétement indépendante" (l. c., p. 260, 261).

[2] "La plume une fois desséchée ne reçoit plus ni sang ni pigment du corps, pas plus qu'elle ne croit encore par sa base" (p. 266).

[3] ". . . . et nous voyons un exemple du second dans l'apparition, souvent si prompte, d'une nouvelle coloration pour quelques parties du plumage de certains oiseaux, comme dans la calotte du *Larus ridibundus*. Tandis que beaucoup de plumes sont renouvelées au printemps à la tête de ce Larus, plusieurs passent, en effet, très-vites du blanc au brun, en peu de jours même, comme Yarell [sic] affirme l'avoir observé" (l. c., p. 267).

tained therein, he being led to this by sundry primitive experiments of his of soaking feathers in oil. Through the supposed action of fat, moisture, light, heat and cold, either separately or variously combined, he attempts to account for a wide range of color changes, either real or imaginary, but mainly the latter. Yet he discards Weinland's hypothesis of the passage from the body into the feather of a colored fat capable of tinting the feather, and also Severtzof's supposition of an extraneous foreign principle, 'l'ozon,' which penetrates the feather and dissolves in it the pigment, and which then, through a process of endosmosis, colors all its different parts. Without taking space here to refer in detail to his experiments, explanations and arguments, we may give the gist of his conclusions in the following extract: "Ainsi donc, sous l'influence, d'abord d'une humidité tour à tour absorbée et évaporée, comme agent développant préparateur, puis de la graisse du corps comme dissolvant, puis enfin de la température et de la lumière comme agents facilitant les actions chimiques, la plume se colore, change ou augmente sa coloration" (l. c., p. 279).

The action of humidity, in his hypothesis, plays a minor but important part in expanding the cortical substance of the feathers, the chief rôle being that of the fats from the body, which by some means, either external or internal, gain access to the pigment granules and dissolve them, so that the coloring matter is, at least hypothetically, held for the most part in solution, subject to extravasation, to transportation, and even to decoloration. As, however, his treatment of the subject is for the most part in generalities, and from a purely hypothetical basis, and as his illustrations are often obviously malapropos—changes of coloration well known to be brought about by molt being cited as illustration of changes of color without molt—his conclusions seem scarcely entitled to serious consideration. Nor do they appear to have made a very profound impression upon the literature of the subject.[1]

Since 1866 little has appeared on the subject of change of color in feathers. Although the erroneous character of the theories and opinions of Schlegel, Gloger, and Gätke was soon made thor-

[1] We do not refer here to his earlier chapters, which, although tainted with his hypothesis of the solution and transformation of the coloring matter of feathers, are, for the time, important contributions to our knowledge of the growth and structure of feathers.

oughly evident, similar beliefs have still a firm lodgement in the minds of many writers of the present day. Not only has Herr Gätke republished his early absurd views within the last few years, but similar notions appear to have arisen independently among those who have perhaps never read either Schlegel's or Gätke's papers, or the later memoirs of Severtzof and Fatio.

And now comes the exceedingly unpleasant duty of instancing a few modern cases of belief in the addition of pigment, and its free movement, in old feathers. A conspicuous instance is of course Mr. Charles A. Keeler,[1] who believes that pigment "travels through the various branches of the feather, advancing farthest and most rapidly along the lines of least resistance and accumulating in masses where the resistance is greatest," etc. (l. c., p. 159). In other words, the inference is fairly deducible that the feather first grows and is then decorated, and may also change color by "an addition of pigment without moult."

Mr. F. W. Headley[2] evidently accepts a somewhat similar view, as he says: "A far more remarkable cause of change of colour [than the shedding of the tips of the feathers] is the entrance of fresh colouring matter into the feather, which cannot therefore be an entirely dead thing. This is what takes place when the Blackheaded Gull puts on his spring head-dress, the colour, according to Gätke [!], appearing first at the edges of the feathers and gradually extending till the whole is dyed. In winter the breast of the Dunlin is almost white, in spring it becomes black, the pigment working its way to every part of the feathers through channels as yet undiscovered. By a similar process the head of the Little Gull changes in spring from white with a dash of ashen-gray to black," etc. (l. c., p. 160).[3] To show how little Mr. Headley really knows of the subject of which he is here writing, it is sufficient to say that these and all the other species he mentions in this connection, as the Knot, Wood-sandpiper and Herring

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[1] Evolution of the Colors of North American Land Birds. 8vo, San Francisco, 1893.

[2] The Structure and Life of Birds. Sm. 8vo, London, 1895.

[3] Mr. Headley is evidently not the only one who has been dazed or misled through lack of familiarity with the subject, by Gätke's strange statements. Thus a writer in 'The Auk' (XII, 1895, p. 346) alludes to Gätke's researches in the field of 'aptosochromatism' as an "extremely valuable" contribution to the subject, and proceeds to approvingly enumerate its leading points. Also a reviewer of Gätke's work in 'The Ibis' (Jan., 1896, p. 142) refers to the chapter "relating to colour changes without a moult" as "perhaps the most valuable chapter in the book"! In this relation attention is called to Mr. Chapman's paper (*antea*, pp. 1–8) on 'The Changes in the Plumage in the Dunlin and Sandpiper,' written apropos of this particular chapter in Mr. Gätke's book.

Gull, are birds that have long been known to acquire their breeding dress by a spring molt.[1]

It is even more surprising to find men of the scientific standing of Dr. R. Bowdler Sharpe asserting that the striped plumage of the young Sparrow Hawk (*Accipiter nisus*) becomes changed to the barred plumage of the adult through "a gradual change in the markings of the feather, and not by an actual moult,"[2] or that *young* Wagtails (*Motacilla lugubris*) gain their first full spring plumage by a molt, while the old birds of the same species do *not* molt in spring, but acquire gradually the black on the back and throat "without loss of a feather;"[3] the same being also affirmed of other species of the genus *Motacilla;* although Meves and various other writers ascribe to these birds a spring molt, through which they obtain their breeding dress.

Also that Mr. W. R. Ogilvie-Grant should assert that the female Red Grouse (*Lagopus scoticus*) acquires its summer dress mainly by molt, but partly by a change in the spring in the pattern of the markings in some of the "same feathers which in autumn and winter" were differently marked;[4] or, as he more fully states it: "The summer flank feathers are produced in two ways, either by the gradual rearrangement and change in the pigment of the autumn feathers or by moult. In some birds the whole of the alteration in the plumage of the flanks is produced by change of pattern in the old autumn feathers, in others the change is entirely produced by moult, while sometimes both methods are employed by the same individual. In the former case the first indication of the coming change may be observed in the beginning of the month of November, or even earlier, when many of the flank feathers show traces of an irregular buff stripe or spot next the terminal half of the shaft. As the bird only changes about half the flank feathers, these buff marks are only to be observed on such as are destined to undergo alteration of pattern, which, roughly speaking, means every second or third feather. The buff gradually spreads along the shaft, then becomes con-

[1] See, for example, Macgillivray's 'British Water Birds,' under these species, to say nothing of authorities already cited in other parts of this paper.

[2] P. Z. S., 1873, p. 418.

[3] Cat. Birds Brit. Mus., X, 1885, p. 461.

[4] Cat. Birds Brit. Mus., XXII, 1893, p. 37, footnote.

stricted and broken up into patches, which gradually spread laterally towards the margins of the webs, forming wide irregular buff bands. Meanwhile the interspaces become black, and the rufous of autumn dies out.... It may very naturally be asked why some females should change their flank feathers by moult, while others are enabled to go through the much less exhaustive process of redecorating their old autumn feathers and making them serve the purpose of new summer plumage. This is a difficult question to answer, but it seems natural to suppose that the more vigorous birds gain their summer flank feathers by moult, while nature has enabled the weaker individuals to obtain the necessary protective nesting plumage by a more gradual and less exhaustive process."[1]

In view of what is known of the growth and structure of feathers, and of the character and nature of pigment, such suggestions as the above are simply incomprehensible. To speak, as above, of the "redecoration" of feathers, through the "rearrangement and change in the pigment," involving both change of color and "change of pattern" in the markings, is to imply histological conditions such as no microscopist in studying feather structure has yet discovered; and not only this, but such a reorganization of the internal structure of a practically lifeless organism as is entirely opposed to the known conditions of the case.[2] On the other hand a more reasonable explanation is available. Every ornithologist of experience knows that in birds which are several years in acquiring their adult plumage, or which have a very varied and irregular pattern of markings, it is possible to find, by means of a good series of specimens, almost every imaginable stage and combination of markings, and such a connected series of gradations, as to seem to prove a continuous change in both color and markings from the younger stages to the adult by simply change of color without a molt. In other words, a given molt by no means affects all individuals alike, but carries some to a considerably more advanced stage in the series of changes than others; also, that in the case of irregular and varied patterns of color markings,

[1] On the Changes of Plumage in the Red Grouse (*Lagopus scoticus*). Annals of Scottish Nat. Hist., No. 11, July, 1894, pp. 129–140, pll. v and vi. The above extract is from pp. 135–137.

[2] The consideration of the microscopical structure of feathers, and the nature of pigment as affecting coloration, is quite beyond the scope of the present paper, respecting which the reader is referred to Dr. Gadow's well-known memoir 'On the Colour of Feathers as affected by their Structure' (P. Z. S., 1882, pp. 409–421, pll. xvii, xviii), and the papers he there cites.

it is not uncommon to find in one and the same individual, feathers, so far as their markings are concerned, which represent phases peculiar to several distinct molts. Indeed, it was just such intermediate stages, combined with hasty observation and faulty reasoning, that led Schlegel, half a century ago, to announce that nearly all birds obtain their breeding dress simply by change of color in the feathers without molting, and later misled Severtzof, and Fatio to the construction of elaborate theories to account for imaginary facts.

If one will take a good series of specimens in molt (unfortunately such specimens are rare in collections[1]), in the case of species which are alleged to, and which have the appearance of, changing color without molting, it will be found that the particolored and apparently changing feathers have this appearance when they first break from the sheath in which they are formed, and that these deceptive feathers have not necessarily acquired their peculiar appearance by a subsequent and quite inconceivable change in the amount, arrangement and character of the coloring matter.

As already shown, and as most ornithologists know, many birds do undergo great change of color without molting; but it is equally well known that this striking change in color, as from the winter to the breeding dress, is due not to any addition of pigment, or to any marked change of color in the feathers, but simply to a gradual wearing off of the light colored edges of the feathers of the winter dress, leaving, as the breeding season approaches, the already existent colors of the breeding dress exposed. Combined with this is more or less blanching of the color of certain parts. Striking illustrations of such changes are afforded by the Snow Bunting (*Plectrophenax nivalis*),[2] the Bobolink (*Dolichonyx oryzivorus*), and numerous other species that might be mentioned. In a less striking degree the change is common to nearly all single-molting birds, and also to many that undergo a second or spring molt, in which the feathers of the new dress are at first more or less dis-

[1] It is to be regretted that birds in molt are generally looked upon by collectors, and too often by ornithologists, as undesirable because not in 'good plumage,' whereas such specimens often prove to be the most valuable and instructive that can be obtained.

[2] On this species see *antea* (pp. 9–12), Mr. Chapman's paper, entitled 'On the Changes of Plumage in the Snowflake (*Plectrophenax nivalis*).' Also the same author's papers 'On the Changes of Plumage in the Bobolink (*Dolichonyx oryzivorus*),' Auk, VII, 1890, pp. 120–124, and *ibid.*, X, 1893, pp. 309–341, pl. vii.

tinctly skirted with a fringe or superficial wash of ash, buff or olive, which more or less quickly disappears, often by the double process of abrasion and fading. Exposure to the elements and friction also produce more or less marked change in color where there is no conspicuous loss of tissue from the border of the feather. Generally this is simply an obvious loss of color by fading, but in some instances the color becomes somewhat heightened, as in the case of some browns which change from a grayish brown to a more reddish tint; this may be due in part to abrasion, but probably somewhat also to chemical action consequent on exposure. In such changes, however, there is no transposition of pigment, nor any radical modification of pattern—no "redecoration," and no transformation of white feathers into black—but merely a slight change in tone.

It is noteworthy that while many writers have believed in and have advocated change of color in feathers, of even the most radical kind, the theories as to the causes and methods of the change are as diverse and as numerous as their ingenious inventors. In several instances the fat of the body has been presumed to be the vehicle of the colored secretion that is supposed to flow, by imbibition, or capillarity, or by some unknown process, from the body into the feather; in one case (Fatio) it is not a vehicle for the transportation of pigment, but merely a solvent for the pigment granules already in the feather; in another case a 'secretion' (not a fat) flows from the body into the feather and spreads by endosmose to its remotest cells, depositing in layers the pigment it carries till the feather is duly colored (Severtzof). How the supposed secretion, which mechanically (not physiologically) acts as the coloring agent becomes charged with its burden of pigment no one really attempts to explain; yet some of these theory builders do confess themselves puzzled to understand how under this mechanical or 'purely physical' (Severtzof) process the pigments can so accurately assort and arrange themselves as to produce the color patterns of variegated feathers.

While there may be a slight basis in fact for some of these speculations, if there really is such a thing as an increase in the quantity, and any radical change in the position, of the pigment in a dead feather, it is still, as stated by Bachman in 1839, by virtue of "some new law of nature not hitherto discovered." Finally, as has already been stated in substance, the inventors of these diverse theories have assumed, and attempted to explain, conditions that in nine cases out of ten had no existence; namely, a color change, demonstrably due—normally at least—to molt, which they have supposed must happen in some other way.

Supplemental Note on the Spring Molt of the Bobolink.—Since the foregoing was made up for the press I have had opportunity, through the kindness of Mr. Thomas Proctor of Brooklyn, of examining *twenty-five* live Bobolinks (*Dolichonyx oryzivorus*) in the bird stores of that city, and two others in Mr. Proctor's own extensive aviary. The examination was made on the 14th of March, and the molt was in all stages, from birds showing only here and there the tip of a black feather on the breast, to those that were in nearly full breeding dress. A large number were in the highest stage of the molt, pin-feathers being distinctly visible, especially among the wing-coverts and scapulars and interscapulars, even when the birds were several feet distant. Generally the black appeared in patches scattered irregularly through the autumn plumage; on the lower parts, where the change was most striking, sometimes the black prevailed and sometimes the olive buff tints of the fall dress. In short, the birds presented the same conspicuously pied appearance seen during the molt at the end of the breeding season, except that the incoming colors were reversed, the black now replacing the autumn dress instead of the reverse.

Of course, since the publication of Mr. Chapman's papers 'On the Changes of Plumage in the Bobolink' (cited *antea*, p. 42, footnote 2), there has been little reason to doubt that the Bobolink acquired its breeding dress by a spring molt; yet as his conclusions were based on the examination of scanty material, and as there has been a tendency in some quarters to question their correctness, and as the contrary has often been asserted (see the case of Ord, *antea*, p. 16), it seems worth while to record in this connection the overwhelming proof of the fact I am now fortunately able to adduce.

Article IV.—NOTE ON MACROGEOMYS CHERRIEI (ALLEN).

By J. A. Allen.

Plate I.

In December, 1893 (this Bulletin, V, p. 337) I described as new a form of *Geomys* from Costa Rica, under the name *Geomys cherriei*, the description being based on a single immature specimen. The species was redescribed from the same specimen and the skull figured by Dr. C. Hart Merriam in his 'Monographic Revision of the Pocket Gophers' (North Am. Fauna, No. 8, p. 194, Pl. xv, Fig. 1, Jan., 1895), under the name *Macrogeomys cherriei* (Allen). Through the kindness of Señor Anastasio Alfaro, Director of the Costa Rica National Museum, I have before me five additional specimens, four of which are fully adult, and the other about half grown. The six specimens differ very little in coloration, all being dark sooty or plumbeous brown above and light, soiled grayish white below, slightly darker or more ashy gray over the pectoral region, the line of demarkation between the upper and lower surfaces being well defined. They all possess the prominent squarish or subtriangular white patch on the top of the head noted in the type, and thought possibly due to albinism. It proves, however, to be a normal and striking feature of the coloration. As regards external characters, there is nothing further to add to the original description, the skins being unfortunately not in condition to admit of satisfactory measurement. Señor Alfaro (in litt. May 31, 1895) says, however, that an adult male measures: head and body, 230 mm.; tail, 90; total length, 320. In the adults the length of the hind foot averages about 45 mm.

An adult male skull measures as follows: Total length (condyle to front base of incisors), 59 mm.; zygomatic breadth, 39; greatest breadth across squamosals, 33.5; interorbital breadth, 10; breadth of muzzle at root of zygoma, 13.5; length of mandible (without incisors), 14; greatest breadth of mandible at the angular processes, 37.5; length of upper molar series (crown surface), 11. Ratio of zygomatic breadth to total length, 66.

From Señor Alfaro I learn that all of these specimens, including the type of the species, were taken on his father's plantation 'Santa Clara,' in the small town of Jiménez, on the Atlantic slope, at an altitude of only 700 feet above the sea. He also writes that *Geomys heterodus* Peters, which he describes as a very different animal from *M. cherriei*, is found only at an elevation of 6000 to 7000 feet. *M. cherriei* is very abundant about Jiménez, and very destructive to the coffee plantations. Seventy were taken in a single month on his father's estate.

The Museum is indebted to Señor Alfaro for several specimens of this interesting species, the type of which (Am. Mus. No. $\frac{10768}{9067}$) is also now the property of the Museum.

The accompanying figures (Pl. I) represent the skull of an adult male (Am. Mus. No. $\frac{10770}{9069}$), natural size. The specimen was taken at Jiménez, Costa Rica, in May, 1895, and forms one of the series referred to above.

Article V.—ON MAMMALS COLLECTED IN BEXAR COUNTY AND VICINITY, TEXAS, BY MR. H. P. ATTWATER, WITH FIELD NOTES BY THE COLLECTOR.

By J. A. ALLEN.

The Museum has recently received from Mr. H. P. Attwater, of San Antonio, Texas, about 400 specimens of mammals, collected chiefly in the vicinity of San Antonio, in Bexar County, but including many from Kerr County. The specimens represent 37 species, on which Mr. Attwater contributes valuable field notes, and also important information on 10 other species found now or formerly in the vicinity of San Antonio. These are mainly the larger Carnivores and the larger game animals, as the Deer, Bison, etc., which are all now rapidly disappearing from the State. It hence becomes desirable to place on record the notes on their former status contributed by Mr. Attwater.

I am also indebted to Mr. Attwater for the following sketch of the topographic and other features of the region, and for interesting notes on the effect upon animal and plant life of the severe and long-continued droughts that periodically visit this portion of Texas.

CHARACTER OF THE REGION.—Bexar County is on the line of junction of two regions of diverse topographic character, and is thus faunally a point of special interest, forming, as it does, about the eastern limit of various western forms, and the western limit of various eastern forms of animal and plant life. At about this point also various northern forms find their southern, and various southern forms their northern limit of distribution.[1] The following somewhat detailed account of the region is from Mr. Attwater's MS. notes.

"The city of San Antonio has an altitude of 680 feet above sea level, and is situated about 150 miles northwest of Rockport and

[1] *Cf.* Attwater, The Auk, Vol. IX, 1892, pp. 229, 230.

Corpus Christi, on the Gulf coast. For about 50 miles inland from these points the country is flat, but gradually becomes more rolling in Bee County, this character increasing till Bexar County is reached, where, directly north of San Antonio, the first elevation begins, and the country becomes rough and broken, the underlying rock being a soft cretaceous limestone. This elevation extends northward from San Antonio across the State, and also westward to the Rio Grande. The counties north and west of Bexar are much cut by erosion, which has formed terraced hills, covered with boulders, and deep valleys or cañons with steep rocky sides. In direct contrast with this rough region is the lower and more level country, beginning directly south of the city and extending to the mouth of the Rio Grande. The soil, south of this dividing line in Bexar County, is more or less sandy, with what is known as chocolate land (a mixture of reddish clay and sand) along the streams, while north of this line it is black, waxy, and mixed more or less with stones and gravel.

"The San Antonio River, a good sized stream, rises two miles north of the city, in some large springs which flow from the limestone. The Medina River, joined by the Leon, runs through the southern part of the county, and unites with the San Antonio River fifteen miles south of the city. Both the Medina and the Leon are dry most of the year, but water is always to be found in large pools and deep water-holes along their courses.

"The old settlers inform me that formerly the country around San Antonio, away from the streams, was open prairie, but now where it is not in cultivation it is covered with a thick growth of mezquit trees, and in some places with dense growths of thorny bushes and cactuses (*Opuntia*). The entire region north and south of San Antonio is well wooded, and next to the mezquit the prevailing growth on the upland is live oak, post oak and hackberry, with pecan, cottonwood, willow, elm, box-elder, sycamore, mulberry and cypress along the streams and creeks.

"Two miles south of the Medina River there is a long stretch of light sandy soil, extending into the adjoining counties, which is covered with a heavy growth of black oak and hickory. This particular locality is similar in character and supports the same growth of weeds as the sandy soil in Aransas County, on the coast.

"The mountain region north and west of San Antonio is mostly covered with spanish oak, shin oak and dwarf live oak, with much red cedar (*Juniperus*) scattered in places along the ridges and hill-sides, often forming almost impenetrable 'brakes.'

"Many varieties of smaller trees, shrubs, vines, etc., grow throughout this region, along the creeks and ravines, and in the river bottoms, producing fruit, berries, etc., which provide an unlimited food supply for the wild animals. Good crops of the following are produced almost annually in a wild state: Wild grapes (several varieties), mulberries, dewberries, hackberries, barberries (*Berberis trifoliata*), cherries, plums, persimmons, acorns (many varieties), pecan nuts, walnuts, and hickory nuts. In addition to these and many other kinds of nuts and edible berries, there are numerous varieties of weeds which yield large quantities of seed, such as the wild sage (*Croton*) and sunflowers, and a host of other weeds, the seeds of which are eaten by rats, mice, pocket mice, kangaroo rats, etc.

"Most of the specimens sent were collected at odd times, during the last two years, and nearly all of them from two localities in this county, one of these places being around our house, three miles south of the city, and the other on Mr. John Watson's ranch, on the Medina River, about fifteen miles southwest of San Antonio, where I have made a number of trips to collect and hunt animals. I was particularly fortunate in having the assistance of Mr. Watson and his sons, who generally accompanied me, and who sent me many specimens, and furnished much valuable information.

"I also received much assistance from Mr. Gustave Toudouze, a good hunter and taxidermist, who also lives on the Medina River, and who had a fine collection of the large animals at the New Orleans Exposition in 1884. I have also had the advantage of being acquainted with Mr. David Menck, the proprietor of the Zoölogical Gardens in San Antonio, who owns a fine collection of live animals, and who has furnished me much useful information.

"Several trips were made to Kerr County, where some of the specimens sent were taken. They were caught at the ranch of my friend, Mr. Howard Lacey, on Turtle Creek. Mr. Lacey, besides having hunted deer and large animals for a number of years, is a careful and reliable observer. I am indebted to him for many favors, and his note-book, which he placed at my disposal, afforded me much interesting and authentic information.

"EFFECT OF DROUGHTS ON ANIMALS.—Southwestern Texas is subject to periodical droughts, which render agricultural pursuits very uncertain, and, I am convinced, have a great influence on the lives of the animals here, especially the mice and rats which live above ground or have their nests and hiding places close to the surface.

"Several wet and rainy seasons are generally followed by several dry ones. In 1889, 1890 and 1891 there were good rains in the early part of the year, and fine crops were raised. In these years small animals of several kinds seemed very much more common than in 1892, 1893 and 1894, which were dry years—and especially 1894—during which period a severe drought prevailed all over this section of the State. In 1894 no small grains were raised, and the corn crop was almost a total failure in this county. We had fine rains in 1895, and a splendid crop of small grains and corn matured, and some small animals have of late become much more common, especially since the end of July, 1895. I have recently met with Harvest Mice and Sigmodons in localities where I know they were not to be found last year; and both these species have very recently been reported to me from other points as being noticed the first time for several years.

"In dry seasons the cattle eat off the weeds and grasses, leaving the ground bare, but with the heavy rains in the early part of 1895 the whole country became covered with a dense growth of vegetation, which afforded a hiding place to the small animals and protection from their enemies; besides providing them with an extra supply of food, and much more favorable conditions generally for their existence.

"These conditions do not affect the Pocket Gophers, Moles and Pocket Mice so much as they do the Mice, Rats, Rabbits, etc., whose homes and nests are mostly on or above the ground. When Rats, Mice and Rabbits are common, Skunks and other larger animals are noticeably more numerous."—H. P. A.

1. Didelphis marsupialis virginiana (*Kerr*). OPOSSUM.—Represented by 7 specimens, all from the Medina River bottoms, about 15 miles south of San Antonio. Two of the specimens have the dark coloration, wholly black feet, black basal portion of the tail, and dusky eye stripe characteristic of Rockport, Corpus Christi, and Brownsville specimens;[1] the others are quite like the ordinary northern (*virginiana*) style of this animal.

"Common, but generally met with along rivers and creeks. Black Opossums are occasionally met with, but not as often as at Rockport, on the coast. They eat all kinds of wild berries and fruits, and are especially fond of mustang grapes and persimmons. They also eat lizards and anything in the way of meat they can find. Mr. Lacey says that his dogs have often 'treed' them in the carcasses of dead cattle, and that they make the inside of a dead cow their temporary abode so long as there is anything left on the bones worth picking."—H. P. A.

2. Didelphis marsupialis californica (*Bennett*). TEXAS OPOSSUM.—Two specimens, as stated above—Medina River, Jan. 10 and Dec. 31.

3. Tatusia novemcincta (*Linn.*). NINE-BANDED ARMADILLO.—Although no specimens were sent, the following notes are entitled to record, as this animal is likely to be soon exterminated in the more settled parts of Texas.

"I have records of the capture of the Armadillo from many points north, south and west of San Antonio. Mr. Lacey reports it from Burnet County, 150 miles north of San Antonio, and one was killed this summer (1895) on his ranch in Kerr County. They are occasionally sent to the Zoölogical Garden alive, but do not live long in confinement."—H. P. A.

Mr. Attwater also sends newspaper clippings recording the capture of specimens in Kendall and Gillespie Counties, north of San Antonio, during 1894.

[1] *Cf.* this Bulletin, VI, 1894, p. 168.

4. **Dorcelaphus virginianus** (*Bodd.*). VIRGINIA DEER.—"Deer are still common in Bexar County, and are not as liable to be exterminated here as in other parts of the State, east and north of San Antonio. The immense pastures, enclosed with barbed wire fences, afford them great protection—the fences, sometimes miles in length, preventing hunting parties from leaving the public highways. The almost impenetrable stretches of chaparral thickets also afford them shelter, even when hunters' camps are located among them.

"Formerly, when the country was unsettled, and before the influx of market hunters, the deer, according to the old settlers, could be seen feeding in the daytime, but now they commence to feed about half an hour before sunset, and lie down soon after sunrise. They thus have apparently changed their habits as the country has become more settled."—H. P. A.

5. **Dorcelaphus hemionus** (*Raf.*). MULE DEER; BLACK-TAILED DEER.—"The extreme eastern limit of the range of the Black-tailed Deer is west of Edwards County. I have heard of their being killed in Val Verde County, but they are rare east of the Pecos River."—H. P. A.

6. **Antilocapra americana** *Ord.* ANTELOPE.—"Formerly the Antelope ranged eastward in Texas to within 100 miles of San Antonio and southward along the Rio Grande, but they are not now found so far south in this State. According to Dr. J. B. Taylor—to whom I am indebted for valuable information about the range of this Antelope—there are still about 100 on his ranch in the northwest corner of Sutton County, which he thinks is now about the southeastern limit of their range. A few scattered bunches may still be found eastward to Menard County. A straight line running west from Sutton County, Dr. Taylor thinks, will mark their present southern limit. Another line drawn from Sutton County slightly west of north to Amarillo in Potter County will, he believes, mark their present eastern limit in Texas, although a few may straggle further east."—H. P. A.

7. **Bison bison** (*Linn.*). AMERICAN BISON.—In May and June, 1894, reports[1] came from San Antonio, Texas, of the discovery of a herd of about 40 to 50 wild 'Buffalo' in Val Verde County, Texas, which were so circumstantial as to lead many to believe in the reputed discovery. Later[2] the number had increased to 60, and the herd had left the fertile valleys of Val Verde County and, passing into the valley of the Rio Grande, followed up that stream till they found a convenient crossing place and passed over into Mexico. An expedition which had been organized, with headquarters at San Antonio, for the purpose of 'rounding up' the herd and bringing it into captivity, was therefore indefinitely postponed. Apropos of the foregoing, the subjoined notes from Mr. Attwater, a resident of San Antonio, and an enterprising naturalist as well, become of special interest.

"A year or so ago a herd of Wild Buffalo was reported seen in Val Verde County, 150 miles west of San Antonio, between Devil's River and the Rio Grande. Since then a number of hunters have searched for them, but so far as I know no sign of them has been seen. Many people do not believe the report. If it was correct, it is strange that they have not turned up somewhere since, or at least been heard from in some way.

"Reliable persons tell me that 1886 was the last year for Wild Buffalos in western Texas, and I think it is safe to say there are none in Texas to-day in a wild state. There are several herds in captivity on large ranches in northwestern Texas.

"I send a dorsal vertebra and rib from a mounted Buffalo now in my collection. It was caught when a little calf in a wild state in 1883, in Borden County, at the head of the Colorado River. It was raised by a common cow, and castrated when two years old. It grew to a large size, and was exhibited at the State Fair two years ago. It weighed 3506 lbs., stood 6 feet 4 inches high, and was 10 feet long. It died in 1893, and then came into my possession."—H. P. A.

Later Mr. Attwater wrote me, on the authority of Dr. J. B. Taylor, one of the most prominent stockmen in western Texas,

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[1] 'Buffalo in Texas' (signed 'O. C. G.'). Forest and Stream, XLII, p. 421, May 19, 1894; and *ibid.*, p. 510, June 16, 1894.

[2] 'The Texas Buffalo Herd.' *Ibid.*, XLIII, p. 377, Nov. 3, 1894. From the 'San Antonio Express' of Oct. 6, 1894.

and whose headquarters are in San Antonio, that "the Val Verde Buffalo herd was only a myth." The report appears to have been originally started as a 'joke,' but for a time seems to have been believed in by some of those who were prominent in giving it currency.

8. **Dycotyles angulatus** *Cope.* TEXAS PECCARY.—No specimens were sent, but Mr. Attwater reports a mounted example in his collection, and contributes the following notes.

"Not often met with now near San Antonio, but still common in the chaparral region south and west of San Antonio. Mr. Lacey reports that they were formerly common in Kerr County, but are seldom seen there now.

"Ten years ago there was a great trade in skins and hides of wild animals in San Antonio, and the prices paid by dealers were much higher than now. Hides of the 'Havelina,' as the Peccaries are called here, were in demand, and wagon loads of them could be seen at the depots and commission warehouses. I am informed by Messrs. Cohen & Co. that their firm handled over 30,000 'Havelina' hides in one season, eight years ago. The highest price paid then was 80 cents for a No. 1 hide. They were shipped east, and most of them went to Europe, the skins being used for gloves and the hair for brushes. The price paid now is about 30 cents, with few coming in, and last season's stock still on hand. A ranchman in Zavalla County told me that in 1886 'Havelina' hides were currency in that part of the State. At a store at Luma Vista, in the same county, a small skin would be returned over the counter with a certain quantity of tobacco, etc., in exchange for a large skin.

"They thrive in captivity. A pair in the Zoölogical Garden have bred there for the last six years, bringing their young at any season of the year, and having from one to three at a time.

"The nature of the Peccary seems to have toned down considerably from its old-time ferocity. Formerly, it is said, they knew no fear, but the few herds I have met with showed a very different disposition, being intent only on flight. Probably, however, where they have not been relentlessly persecuted by hunters they still retain their former spirit and bravery."—H. P. A.

9. Lepus merriami *Mearns*. Rio Grande Jackrabbit.

Lepus callotis Baird, Mam. N. Am. 1857, p. 590 (nec Wagler; Texas references only).
Lepus callotis, var. *callotis* Allen, Mon. N. Am. Roden. 1877, p. 350 (Texas references only).
Lepus callotis Allen, Bull. Am. Mus. Nat. Hist. VI, 1894, p. 169. (Rockport and Corpus Christi, Texas.)
Lepus melanotis Allen, *ibid.* p. 348 (the Rockport, Texas, specimens only).
Lepus merriami Mearns, Proc. U. S. Nat. Mus. XVIII, 1896, No. 1075, p. — (page 2 of 'advance' sheet, issued March 25, 1896).

All of the 15 (11 adult and 4 young) Jackrabbits from the vicinity of San Antonio are referable to *Lepus merriami*, recently described by Dr. Mearns (l. c.), as are also the specimens recorded by me from Rockport and Corpus Christi, Texas, provisionally under the name *Lepus callotis*, and later referred in part to *L. melanotis*. Several of the specimens, however, are wholly without black on the nape, and have little or no black at the base of the ears; other examples show more or less black on these parts, grading into those with a large black nape patch and a broad area of black at the base of the ears. This variation is hard to explain, as it is apparently not due to age, sex, or season. The gray-naped specimens prove, on comparison, easily separable by general features of coloration from *L. melanotis*, aside from the presence of good cranial differences.

The collector's measurements of these specimens are as follows, total length and length of tail being taken *to the end of the tail hairs* instead of to the end of the caudal vertebræ. The hairs extend about 25 to 30 mm. beyond the tail vertebræ.

Cat. No.	Sex.	Date.	Length.	Tail.	Hind foot.	Weight.
11861	♀ ad.	Nov. 22.	620	108	127	5 lbs. 12 oz.
11860	♀ ad.	" 29.	626	102	133	5 " 14 "
10314	♀ ad.	Feb. 13.	615	104	131	5 " 12 "
10315	♀ ad.	" 15.	558	95	131	4 " 0 "
10317	♀ ad.	April 17.	604	114	133	7 " 0 "
10316	♂ ad.	June 19.	622	127	131	— —
11859	♂ ad.	Jan. 10.	620	109	130	5 lbs. 12 oz.
11862	♀ ad.	Nov. 8.	—	—	133	6 " 6 "
11857	♀ ad.	" 20.	648	127	133	7 " 0 "
11858	♀ ad.	Dec. 5.	622	108	133	7 " 0 "
11863	♀ ad.	" 28.	610	102	131	7 " 0 "

One of the young ones (March 4) is about one-fourth grown; the other three (Jan. 10, April 12, and July 6) are very young, apparently nurslings. A young Rockport specimen, taken Oct. 11, is only a few days old. A female taken Dec. 8 is labeled as containing one small embryo, and another taken Dec. 28, contained one large embryo. It is thus evident that the young are born at irregular intervals nearly throughout the year.

Mr. Attwater says Jackrabbits are "common everywhere, but less numerous in the broken country north of San Antonio than in the mesquit lands between San Antonio and the Gulf Coast." In winter they feed on the "tips of the mesquit and other thorny shrubs, and even on the leaves of the prickly pear cactus (*Opuntia*)." In winter he has measured their tracks in the snow showing leaps of 15 feet, and thinks "they would do even better than this when pursued by a hungry Coyote."

10. **Lepus sylvaticus bachmani** (*Waterh.*). TEXAS WOOD HARE.—Represented by 16 specimens, 13 of which are adult; the three young vary in age from 10 to 45 days, according to Mr. Attwater's memoranda on the labels. The series is not distinguishable from Rockport and Corpus Christi specimens. The collector's measurements of 10 adults (5 ♂♂ and 5 ♀♀) are as follows: Total length (to end of tail hairs), 409 (380–425); tail (to end of hairs), 55 (45–64); hind foot, 90.6 (85–95).

"Common everywhere, but much more numerous in the chaparral region south of Bexar County, than to the north of it. Two of the young ones are from a nest in our garden. The nest was discovered on July 19—a shallow hole in the ground under a tomato vine, six feet from the kitchen window. It was composed of strips of cedar bark and lined with rabbit fur. It contained three young ones apparently a day or two old. On July 25 their eyes were open. On July 27 one was taken from the nest and preserved as a specimen (No. 134). July 29 the two little ones that remained left the nest, being then about two weeks old. One of them was caught two days later in a steel trap set near the nest. During all this time the old rabbit was not seen. The only time she could have visited the nest was during the middle of the night. The garden was surrounded with what was supposed to be a rabbit-proof fence. I never found where she went in and out. It was a very dry season, and vegetation was everywhere dried up except in this small garden. She evidently selected this so that the little ones would find something to eat. The whole affair was nicely arranged and very well managed for a rabbit."—H. P. A.

11. **Geomys texensis** *Merriam.* TEXAS GOPHER.—Represented by 11 specimens, 7 males and 4 females, collected about 15 miles south of San Antonio. Six adults measure as follows: Total length, 223 (203–237); tail vertebræ, 72 (60–79); hind foot, 27 (25.4–29). These measurements are slightly above those given by Dr. Merriam for his series from Mason County.

Mr. Attwater sends the following interesting notes on the range of Pocket Gophers in Bexar and adjoining counties:

"Pocket Gophers are found only in the sandy parts of the country. They are very common in the extreme southern and southwestern part of this [Bexar] county, their northern limit here being about eight miles south of San Antonio. From San Antonio northward for about 100 miles, or through Bexar, Bandera, Kendall and Kerr Counties, I have never found them. There may be some isolated colonies, if sandy tracts occur in the region embraced in these counties. Further north they will probably be first met with in Gillespie County, just north of the Perdenales River, for I have heard of gopher mounds being seen there. There is, therefore, apparently an area of nearly 100 miles in north and south extent where no Pocket Gophers exist."—H. P. A.

12. **Perodipus ordii** (*Woodh.*). ORD'S KANGAROO RAT.—Represented by 5 specimens, 1 male and 4 females, taken 18 miles south of San Antonio, Aug. 23–Sept. 18. A female taken August 23 contained "two small embryos."

"These beautiful little animals appear to be quite common in the sandy black oak region south of the Medina River in Bexar County. Their burrows seem to be most numerous in the poorest, sandy soil."—H. P. A.

13. **Perognathus paradoxus spilotus** *Merriam.* TEXAS POCKET MOUSE.—A series of 42 specimens, of which all but 8 are adult, seem practically indistinguishable from Rockport examples.

"Much more numerous in the sandy lands than in the black lands; prefer wild land to cultivated fields. Similar in habits to those found about Rockport [see this Bulletin, VI, 1894, pp. 173, 174]. They undoubtedly carry the dirt out of their burrows in their cheek pouches. When kept alive in confinement they become very tame and seem to like to be handled."—H. P. A.

Two were sent alive by Mr. Attwater in May, 1895, to the Museum. One of them died in transit, after reaching New York; the other lived contentedly for weeks, in an open box covered with wire netting, but finally escaped. Mr. Attwater had had them two months before shipping them, during which time they fed readily on cane seed, oats and corn, but had received no water.

14. **Perognathus flavus** *Baird.* YELLOW POCKET MOUSE.—Represented by 26 specimens, 22 of which are fully adult, one is nearly adult, one is about half grown, and two are nurslings.

Two are from Kerr County, and the rest from the immediate vicinity of San Antonio. They were taken mainly between Feb. 25 and May 18, and Sept. 15 and Nov. 20. The two nursing young were taken May 18.

The nurslings are dusky gray above and pure white beneath, with a very narrow sharply defined deep fulvous lateral line, pale fulvous eye-rings and postauricular patches. A half-grown specimen is quite similar in coloration.

Two adults were received alive from Mr. Attwater, one of which is still living at the Museum, apparently in good health after being in captivity for ten months. He is furnished at frequent intervals with little quantities of bird seed, a part of which he eats at once and the remainder he carries into his burrow, working industriously till all is hidden away. Formerly he was given water, bread and a greater variety of food, but the mixed bird seed seems to supply all his needs. As he showed no desire for water, he has been offered none for the last eight months. He is quite tame, has a sleek well-kept coat, and appears to consider his lonely life well worth living.

"Very common, and, like the larger species (*paradoxus*), prefers the sandy land to the black soils, but, unlike *paradoxus*, prefers cultivated lands, and particularly old fields. They are often turned up by the plow in spring, and occasionally hoed up in summer. When turned out and kept alive a cold night will put them to sleep, so that they appear dead in the morning; but they soon recover animation when warmed up and resume eating. I have kept them alive for several months, feeding them with corn, oats, bran, etc. One lived for several months in a cage with a large *P. paradoxus*."—H. P. A.

15. **Mus decumanus** *Pall.* Brown Rat.—One specimen, ♂ ad., San Antonio, Jan. 27, 1894. Total length, 413; tail vertebræ, 209; hind foot, 51.

"Common in the city of San Antonio, but not as yet met with on the ranches."—H. P. A.

16. **Mus musculus** *Linn.* House Mouse.—Represented by 13 specimens, which present a wide range of variation in color. One (No. 10410), not fully adult, is of the clear gray color common to half-grown specimens of *Peromyscus* of the *leucopus* group. Another (No. 10412) is the reddest House Mouse I have ever seen from any locality, not excepting the red desert regions of Arizona. The color above is strongly reddish fawn, much varied with black, while the lower surface is reddish buff. Several others are nearly as red, while one or two depart little from the usual color of the House Mouse.

"The common House Mice are here often found away from houses and buildings, living in holes in the ground and in hollow trees.

"Inside a house, the organ is a place frequently selected by mice in which to make their nests, and they do not seem to mind the noise made by playing on the instrument. I believe that mice have ruined organs in thousands of houses in the United States, and that often when an organ gets 'out of fix,' and the trouble is not exactly known, that the cause may be found inside the case, curled up in a snug nest, a part of which has been gnawed from different parts of the interior of the instrument."—H. P. A.

17. Neotoma micropus *Baird.* TEXAS WOOD RAT.—Represented by 23 specimens, of which 18 are adult and 5 young, taken in the vicinity of San Antonio, in January, February, July, August, October and November. They are not appreciably different from Rockport and Brownsville (Texas) specimens, and Mr. Attwater says they have the same habits.

"Common all over this region. The habits of the San Antonio Wood Rats are the same as those of the Wood Rats at Rockport. When caught in traps by the feet they immediately begin to eat off the limb that is held, and frequently escape in this way. No. 95 [Am. Mus. No. 10365] has both feet missing; the stumps were nearly healed when it was caught the second time in a steel trap. Mr. Watson says he has found a half a bushel of pecan nuts in a Wood Rat's nest. Their nest piles are seldom found on the river bottom lands, but some are met with on the higher pecan lands near the river. Their favorite resorts, however, are the high dry chaparral region.

"These Wood Rats have a habit of stamping with their hind feet when annoyed or disturbed. On several occasions when setting traps for them at their holes I have heard the rats stamping inside. Also on one occasion I saw a rat thus stamping in our greenhouse while sitting in a corner."—H. P. A.

18. Neotoma mexicana *Baird.* MEXICAN WOOD RAT.—Represented by 8 specimens—5 adults and 3 immature—taken on Turtle Creek, Kerr Co., March 12 and Dec. 10–14, 1895. This locality is doubtless on the eastern border of the range of this species, which here meets that of *M. micropus.* The latter is common about San Antonio, where *N. mexicana* has not been met with.

Most of the specimens were dug out from their holes, Mr. Attwater having found it difficult to trap them during his short excursion to the head of Kerr Creek, in Kerr County, where they were obtained, owing to their gnawing off their feet when caught, or being destroyed by predacious animals. He says:

"One of the rats was found under a pile of brush, on damp ground in a creek bottom, and was easily caught. The other five [of the series taken in December] were found on high land—one on an oak ridge and four in a cedar brake—and had to be dug out of their retreats, from two to three feet below the surface, among rocks, at the end of passages six to ten feet long, leading gradually down from their nests.

"All the nests were in heaps of rubbish piled up by the rats; those in the cedar brake were heaped around cedar trees, and the nests were made in the hollows among the roots of the trees. These nests were composed of fine strips of cedar bark; the nest in the creek bottom was made of grasses, leaves, and also cedar bark. Only one rat was discovered in each nest, but several nests were found in some of the heaps. The 'rat heaps,' or mounds of material which the rats pile up over their nests and retreats, average two feet high, and are composed of any kind of rubbish that comes handy, chiefly sticks, stones, and dry horse and cow manure. Like *N. micropus*, they also go into houses and barns on the ranches and build their homes. A favorite place is the corner of some old shed or 'tumble-down' shanty. One we found on Mr. Lacey's ranch was constructed chiefly of stones and old pieces of board, with sticks and other rubbish, including shingles that had fallen from the roof. Some of the stones and pieces of lumber on the pile were quite heavy, and it seemed almost incredible that a rat could have carried them on to the pile. One of the heaviest things, on the top of this particular pile, was a piece of board, 14 inches by 10 inches, and weighing 2½ lbs. These rats, if permitted, will make their abodes under houses occupied by people, and, in the absence of cats and dogs, enter the house and become quite friendly, helping themselves to small articles to add to their pile. In one instance a tobacco pipe was one of the articles taken.

"We found in some of the heaps large quantities of small green cedar boughs. These boughs are cut off the trees by Fox Squirrels, for the purpose of obtaining the cedar berries, which are more easily taken from the branches after they have fallen to the ground. In one of the underground passages at the nest on the oak ridge were found, stored away, about three dozen bunches of wild grapes; also many acorns and black haws. In another nest in the cedar brake were about two dozen small mushrooms, partly dry and shrivelled. All the heaps in the cedar brakes contained large stores of cedar berries, most of them with the outside pulp eaten off, and the seeds eaten out. When the very small size of the seed is taken into consideration, it is surprising what an immense amount of work is necessary before enough can be obtained for a meal, as probably a thousand would be required. One nest contained shells of nuts of the Mexican buckeye (*Ungnadia speciosa*), although these nuts are reputed to be poisonous.

"The range of this rat in this part of Texas will probably be found to coincide with that of *Peromyscus attwateri*."—H. P. A.

19. **Sigmodon hispidus texianus** (*Aud. & Bach.*). TEXAS COTTON RAT.—Represented by 22 specimens, taken mostly between September and February, and all at San Antonio except 2, which were taken at Mr. Lacey's ranch in Kerr County. The San Antonio specimens have a decidedly grayer cast than those from the coast region of Texas.

Mr. Attwater's notes, here following, show that these rats are subject to great variation in respect to abundance at the same locality in different years.

"After the great 'Tramp Rat' raid in 1889, referred to below, these rats gradually disappeared and for several years I lost sight of them entirely, and did not hear of any around San Antonio or in any other parts of Bexar County. It again came to my notice on Feb. 9, 1895, when a young one was taken on Mr. Lacey's ranch, in Kerr County. It was next again noticed at San Antonio on August 17, 1895, when one was taken in a cactus patch not far from my house. This particular patch had been well trapped for Wood Rats for some time previously, and the Sigmodons must have come in from elsewhere. All the specimens now sent, [quite a large series,] were taken in this same patch, which is on high, dry land. They have also become common again in Kerr County. In a recent letter from Mr. Lacey (dated Jan. 26, 1896), he says: 'The garden is full of 'Tramps.''

"In the year 1889, Sigmodons appeared suddenly in this [Bexar] county in great numbers, and were known as 'Tramp Rats.' Where they came from, or from which direction, I have been unable to find out. Thousands first appeared about the 1st of May, and were heard from in all the region for many miles round San Antonio. They were most numerous in the high, dry parts of the country, and were not noticed in the low lands along the rivers. They were very numerous all through the 'chaparral,' and made their nests with the Wood Rats (*Neotoma*) in the bunches of *Opuntia*, with a network of runways leading in every direction, through which they were often seen running in the daytime. They seemed to agree with the Wood Rats, but in the oat stacks and around the ranch buildings, the common Brown Rats fought, killed and ate them. Mr. Watson's boys killed over 100 in one afternoon in a brush fence, and for *several months* their cat used to bring in from 6 to 12 every night. He says that on one occasion, when the rats were thickest, they counted 38 which this cat had piled up in the wood-box during one night for the amusement of her kittens.

"The 'Tramp Rats' played particular havoc with all kinds of grain crops, and corn in particular, but they were not good climbers, and consequently the ears on leaning stalks suffered most. Some farmers lost half their corn crop, and in some instances small patches were entirely destroyed.

"During the winter of 1889 and 1890 Marsh Hawks were very numerous, no doubt attracted by the rats. The hawks were seen skimming over the fields in the daytime chasing the 'Tramps.' In 1890 and 1891 Short-eared Owls, on their way north in the month of March, stopped over to attend to the Sigmodons; in other years I have not noticed these owls during migration. Weasels and Little Striped Skunks were much more common than usual in 1890 and 1891, which I attribute to the same cause. Rattlesnakes and other snakes were seldom seen abroad, and when disturbed in their retreats, were found gorged with Cotton Rats. The large skunks and coyotes hunted them, and dogs, generally in the habit of killing rats and mice, and *shaking* them only, also ate them.

"The bulk of these rats stayed for about eighteen months. After the crops were gathered in 1890, they began to get scarce, and gradually disappeared during 1891. Whether they died out, or 'tramped' out, I am unable to say, but I am inclined to think many of them migrated. Old settlers say they remember a similar invasion about the year 1854.

"No. 29 [=No. 10413, Am. Mus.] is one of the San Antonio 'Tramp' Rats taken Dec. 20, 1890. It appears similar to the Rockport specimens; perhaps a little lighter in color. I also sent several skins and nests at that time to Dr. C. H. Merriam, of the U. S. Department of Agriculture.

"Their nests, made of grass, and easily noticed, were placed on the ground in the middle of clumps of brush and bushes and at the roots of trees. Old stumps, hollow logs, and among weeds, along banks and fence-rows, were also favorite places. When disturbed they retreated into shallow holes in the ground, under the nests, and in these holes other nests were found. The rats were easily got at by digging, and from one to six usually found in a hole."—H. P. A.

20. Peromyscus texanus (*Woodhouse*). TEXAS WHITE-FOOTED MOUSE.—Mr. Attwater's collection contains 11 specimens of a small, short-tailed *Peromyscus*, which Dr. Mearns has kindly examined and identified as above. Seven of the specimens are adult and four are more or less immature.

"These were caught in traps set for Harvest Mice, around the same brush piles. I think they live in shallow holes under the brush piles."—H. P. A.

21. Peromyscus canus *Mearns.*

Peromyscus canus MEARNS, Proc. U. S. Nat. Mus. XVIII, 1896, No. 1075, p. — (p. 3 of 'advance sheet,' issued March 25, 1896).

Represented by 30 specimens, collected chiefly in March, April and July, but a few were taken from October to February. About one-half are adult and the rest more or less immature. They differ chiefly in external features from large series of *P. mearnsii* from Rockport and Brownsville in having shorter and more hairy tails and rather smaller ears. Most of the specimens were taken in the vicinity of San Antonio, but three were collected on Turtle Creek, Kerr County, 75 miles northwest of San Antonio, where, however, the species, according to Mr. Attwater, is apparently not common.

"The White-footed Mice around San Antonio live mostly in holes in trees, and along the rivers in holes, caves, and crevices in the high banks and bluffs. Their nests are sometimes found in beehives, and frequently in old birds' nests, those of the Cactus Wren and Yellow-headed Verdin being often selected, on account of their convenient shape. The mouse makes its nest usually of grasses, weed-stalks, and other soft material. The nest sent to you was found March 29, 1894, in a hole on the bank of the Medina River, and is made of white cotton rags chewed up. The favorite food of this species here is pecan nuts, acorns, corn, various kinds of grain and weed seeds. They store up pecan nuts in hollow logs and piles of cordwood in the river bottoms."
—H. P. A.

22. Peromyscus attwateri ALLEN. ATTWATER'S CLIFF MOUSE.

Peromyscus attwateri ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 330. (Published Nov. 8, 1895.)

In addition to the 14 specimens of this species already recorded (l. c.), 4 have been received since, taken by Mr. Lacey at his ranch in Kerr County, Nov. 15, 1895, and Jan. 7, 1896. Three are adult and the other about half grown. All are males. One of the adults has a small pectoral spot of bright fulvous, making two thus marked in a series of 18 specimens. Mr. Attwater states that Mr. Lacey captured one that was "solid bright chestnut all over the upper parts, and had a very plain breast spot," but that unfortunately it was destroyed by a cat.

23. Peromyscus (Baiomys) taylori (*Thomas*). TAYLOR'S MOUSE.—Represented by 10 specimens, of which only 5 are adult, taken at Watson's Ranch, 15 miles south of San Antonio, March 23, May 9 and 29, and Dec. 28. Also two nests. The adults are quite different from fall adults (Aug. 23–Oct. 15) from Brownsville, the pelage being longer and fuller and more varied with brown; but the difference is doubtless seasonal, as the Brownsville specimens are in the new and only partly-grown fall coat, the pelage being thinner and shorter and more plumbeous.

"The specimens sent were taken under a pile of dry weeds and rubbish in an orchard, where the two nests sent were also found. There were several others with them, which escaped. The two specimens taken in March were kept alive till May 29. They were fed on sugar cane seed, oats, corn and bran. They used to drink water when I put it in the cage, but appeared to do just as well without it. The live one I sent you[1] never got any water.

"One of the nests sent was found by Mr. Watson while digging up a small pecan tree in the river bottom near his ranch. The nest was about a foot below the surface of the ground among the roots of the tree, and several passages led down into the ground, below the nest. In one of these holes a number of pecan nuts were found. The nest contained an old female and three half-grown young.

"This mouse evidently is likely to be met with in any locality, as I have found it in all kinds of country. It is not numerous, nor easily found, but one occasionally gets into traps which are set for *Perognathus*, *Peromyscus*, and *Reithrodontomys*. It is apparently evenly distributed, and not restricted, like some other small mammals, to certain kinds of places."—H. P. A.

24. **Reithrodontomys mexicanus intermedius** *Allen.* Rio Grande Harvest Mouse.—Represented by 9 specimens, 6 of which were taken at or near San Antonio (May, August, January, February and March), and 3 at Turtle Creek, Kerr Co., (January and February). They do not differ appreciably from a September series from Brownsville, Texas, except that all but three (August specimens) are in softer, longer and much fuller pelage. Two of the August specimens differ from the rest of the series in rather more rufous coloration. One of these, a female, bears on the label: "Found, with three young, in a nest in a peach tree in Watson's orchard, August 23, 1895."

"I am inclined to think the Harvest Mice are not as common as they used to be, and Mr. Watson is of the same opinion. I used to come across them occasionally in 1889 and 1890 while hunting for birds' nests on the Medina River. They were

[1] This specimen was received in good condition, and lived in confinement for about two months, when it died. It subsisted chiefly on bird seed, which it preferred to bread. Water was placed in its cage at intervals, but it was not seen to drink.

found singly, in the daytime, in little round nests, made of fine grass, placed in the lower branches of small trees."—H. P. A.

25. **Reithrodontomys dychei** *Allen.* DYCHE'S HARVEST MOUSE.—Represented by 28 specimens, mostly more or less immature, taken at San Antonio, Dec. 13, 1895, to Jan. 23, 1896, except one, taken at the same locality Sept. 21, 1895. This species I have previously recorded (this Bull., VII, 1895, p. 236) from Mason, Mason Co., Texas. The present locality is within the range of *R. mexicanus intermedius*, both species occurring together in the same field at San Antonio, showing that their ranges overlap.

26. **Sciuropterus volans** (*Linn.*). FLYING SQUIRREL.—Mr. Attwater reports a single specimen taken on the Guadalupe River, 40 miles east of San Antonio.

27. **Sciurus niger limitis** (*Baird*). PECOS FOX SQUIRREL.—Watson's Ranch, Medina River, 15 miles south of San Antonio, Dec. 4, Jan. 10, June 22—8 specimens; Turtle Creek, Kerr County, May 23—1 specimen. The collector's measurements of 4 of the specimens (2 ♂♂, 2 ♀♀) as recorded on the labels are as follows: Total length (to end of tail hairs), 532 (483–555); tail to end of hairs, 280 (254–305); hind foot, 64.5 (63.5–66). They vary considerably in color, especially below, one (an old nursing female) having the whole ventral surface pale buffy white, and the outer edges of the tail bordered with the same tint; another is nearly pure white below; six others vary from pale buff below to deep orange. One is apparently albinistic, being brownish yellow above washed with gray, but of the usual orange buff below.

"Common everywhere in this region. Many of them are white beneath, and are said to be the younger animal, but I have taken young squirrels that were *not* white below."—H. P. A.

28. **Spermophilus grammurus buckleyi** (*Slack*). BLACK ROCK SQUIRREL.—Four specimens, Turtle Creek, Kerr County, Aug. 20, Nov. 15 and Dec. 4.

These specimens agree with Dr. Slack's description of his *Spermophilus buckleyi* (Proc. Acad. Nat. Sci. Phila., 1861, p. 314), based on a distorted, flat furrier's skin from Pack-saddle Mountain, Llano Co., Texas, except that the area of black is rather larger and extends further back in two of the specimens, being continued in a broad band on to the base of the tail. The black is pure glossy black, as in Baird's *Spermophilus couchi*, described from two specimens from respectively Santa Catarina, Nuevo Leon, and Victoria, Tamaulipas (Proc. Acad. Nat. Sci. Phila., 1855, p. 332, and Mam. N. Am., 1857, p. 311), which were "entirely of a glossy black." In the Turtle Creek specimens the black merges into the gray of the sides, occupying nearly the whole of the dorsal aspect as far back as the middle of the back, where it gradually becomes restricted to the middle of the dorsal area, leaving the posterior third of the body mostly gray. Here, and on the ventral surface, however, the black basal portion of the pelage more nearly approaches the surface than in normal specimens of *grammurus*, imparting to these parts a darker general effect.

In general appearance this semi-black form of Rock Spermophile strongly suggests a melanism of *S. grammurus*, but its local and yet somewhat extended distribution in southwestern Texas seems to imply that it is not strictly comparable to the black phases so often met with in various species of *Sciurus*, it having a distinct geographic range where it occurs to the exclusion of the ordinary phase of *grammurus*. It is, however, quite variable in respect to the extent of the black area and the manner of its distribution, even in individuals taken at the same time and place. Apparently also the amount of black increases from the northern part of its range southward, becoming wholly black in *S. grammurus couchi* in the region south of the Rio Grande.

Respecting its distribution and habits in the region northwest of San Antonio, Mr. Attwater contributes the following:

"These Black Rock Squirrels are found in the cañons and ravines around the heads of the Medina and Guadalupe Rivers. The nearest point to San Antonio where I have heard of their being seen is on San Geronimo Creek, at Gallagher's Ranch, 25 miles northwest of San Antonio, where a single one was seen several years ago by Mr. Frank Edwards, an enthusiastic hunter and close observer. This must have been a straggler, as I should not expect to find their regular range nearer than 60 miles northwest of San Antonio, near the northern border of Bandera County, nor to find them common till well into Kerr County. There is a colony at the head of Johnson Creek, a fork of the Guadalupe River, about 20 miles north of Kerrville. On May 9, 1895, I visited this locality with Mr. Lacey to procure specimens. We watched the cliff, where the squirrels live, for more than an hour from the opposite side of the cañon, during which time a dozen or more, of various ages, came out of the holes and crevices in the rocks. We peppered them with small bullets and coarse shot. Two or three were killed outright, and others were wounded, but we were obliged to leave them on the inaccessible ledges, and reluctantly returned without securing a single specimen. Some of the largest appeared very black, but some of the smaller ones were of a grayish color all over. The four specimens sent you are from the head of Turtle Creek in Kerr County, and were kindly obtained and prepared for me by Mr. Lacey.

"These Rock Squirrels are not generally distributed over the country, like the Tree Squirrels, but live in colonies, a dozen or more miles apart, and generally in some favorite cliff or cañon near the heads of the creeks that form the sources of the rivers. When occurring near ranches these squirrels do considerable damage to the gardens and cornfields. They are expert climbers, making their way up the perpendicular faces of cliffs with ease. Unless disturbed or alarmed their progress is slow and their movements are more like those of a creeping reptile than the lively skip of a squirrel. If they bounded swiftly from rock to rock there would be nothing to excite surprise, but when seen slowly crawling along the underside of an overhanging ledge of apparently smooth limestone one's curiosity is excited, and you watch their movements with surprise. On being alarmed, however, they move with great quickness.

"This is the only Spermophile I have met with near San Antonio, Bexar County being apparently outside of the range of either *Spermophilus mexicanus* or *S. tridecemlineatus*. The former may occur not far from the southwestern border of this county, or on the other side of the Medina River, 25 miles south of San Antonio, where *Perodipus* is found."—H. P. A.

29. **Cynomys ludovicianus** (*Ord*). PRAIRIE DOG.—"Bexar County is outside of the Prairie Dog region, but I saw one in a wild state on a ranch about twenty miles west of San Antonio in 1889. It made its burrow near the ranch, and was finally killed by hunters."—H. P. A.

30. **Castor canadensis** *Kuhl.* BEAVER.—Mr. Attwater reports the Beaver as formerly found northwest of San Antonio, and states, on the authority of Mr. Lacey, that it is still found sparingly on the Little Llano and Perdinales Rivers. Mr. Attwater also sends a newspaper record of the capture of a specimen by a trapper near San Angelo, about April 10, 1895, weighing 82 pounds.

31. **Nyctinomus brasiliensis** *Is. Geoffr.* HOUSE BAT.—Represented by a series of 15 specimens, two of which are from Kerr County, and the rest from the immediate vicinity of San Antonio. Mr. Attwater says this is the most common of the Bats, and that it lives in holes and crevices in the roofs and walls of houses. He also contributes the following interesting note on Bat caves:

"Large bat caves are found in the rough limestone region north and west of San Antonio, particularly in Bandera, Medina, Uvalde, Edwards, and Kerr Counties. In some places a good business is done in gathering bat guano for the market. I visited one of these caves near the head of Turtle Creek in Kerr County. We entered the cave at night with lanterns, hoping to secure some bats. There were several hundred in sight flying about when we entered, but they quickly retreated into holes and cracks. We then tried to knock them down outside the cave with sticks and stones, but they all eluded us. There appeared to be two kinds of bats, one much larger than the other. The guano was about three feet deep on the floor of the cave. Although this was a comparatively small cave, we estimated that there were two hundred large sacks full in sight."

32. **Atalapha borealis** (*Müller*). RED BAT.—One adult female, with three young, taken May 13, 1894.

"Quite common; found hanging to the branches of trees. The three young specimens in alcohol were found clinging to the nipples of the mother."—H. P. A.

33. **Atalapha cinerea** (*Beauv.*). HOARY BAT.—One specimen.

"Taken near Cubbra Springs, 18 miles west of San Antonio, by Mr. Steven Kearney, who found it hanging on a hackberry tree. He does not remember the exact date, but is certain it was in the early part of the summer of 1891."—H. P. A.

34. **Vespertilio** sp.?—Three specimens, San Antonio, March 12 and Oct. 11, 1895. Mr. Attwater reports the capture of still another specimen on Nov. 11, 1895, but the species does not appear to be common. It is a large form of the *lucifugus* group.

35. **Scalops texanus** *Allen.* TEXAS MOLE.—Two specimens from the vicinity of San Antonio are not distinguishable from Rockport specimens (see this Bulletin, VI, 1894, pp. 184–186).

"Not nearly so numerous as at Rockport. Found only in sandy soil. They do much damage in vegetable gardens by eating newly-planted seeds. I think the chestnut-orange shade is a feature of the adults, it being less marked, or even quite lacking, in young specimens."—H. P. A.

36. **Notiosorex crawfordi** *Baird.* CRAWFORD'S SHREW.—Represented by a single specimen, "found dead at entrance to a hole at the foot of a mesquit bush, on high land one mile east of San Antonio." Mr. Attwater also states in his notes: "In 1889 I caught several specimens of this Shrew in a hole I dug close to a pond. I have not met with any for several years, except the one here sent, and believe they are much less common than formerly, an opinion also shared by Mr. Watson."

Dr. Merriam also refers (North Am. Fauna, No. 10, Dec., 1895, p. 33) to a specimen received from Mr. Attwater collected at San Antonio in 1890.

37. **Ursus americanus** (*Pall.*). BLACK BEAR.—Represented by a single skull, from the head of the Nueces River.

"Black Bears are still found in localities at the head of the Nueces River, and in the Devil's River region, where the immense and almost impenetrable cedar brakes afford them protection. Ten years ago they were common in parts of Bandera and Kerr Counties. Mr. Lacey informs me that at that time 'Bear bacon' was nearly always to be found at any of the ranches on Turtle Creek, and that it was almost impossible to raise hogs on account of Bears eating the young pigs.

"A pair of Black Bears have bred three times in the Zoölogical Gardens at San Antonio, each time bringing forth the young early in spring. There were three or four in each litter, about the size of rats, and they were eaten by the old ones each time."—H. P. A.

38. **Procyon lotor hernandezii** (*Wagler*). RACCOON.—Two specimens, ♀ ad. and ♂ juv., from the vicinity of San Antonio.

"Common throughout this region, but most often met with along the rivers, where they live in the holes and crevices in the high bluffs. They are very fond of the fresh-water mussels, and eat lizards whenever they can catch them."—H. P. A.

39. **Bassariscus astutus** (*Licht.*). CIVET CAT.—Although not represented by specimens, Mr. Attwater contributes the following:

"More common in the rough country north and west of San Antonio. In captivity they become quite tame, and live comfortably; but I have not heard of their breeding in confinement. In a wild state they live principally on birds and mice, and are said to be expert mice catchers."—H. P. A.

40. **Conepatus mapurito** (*Gmel.*). WHITE-BACKED SKUNK; BARE-NOSED SKUNK.—"I have heard of several being killed here, and Mr. Toudouze, a taxidermist, has a mounted specimen in his collection which was killed on the Medina River, in Bexar

County, and Mr. Lacey informs me that the species is still found in Kerr County, but that it is not common."—H. P. A.

41. **Mephitis mesomelas** *Licht.* TEXAS SKUNK —Three specimens—a young female about one-quarter grown, Aug. 6, and an adult male, Aug. 16, 1895, from San Antonio. Also an adult male, "caught alive, when about half grown, seven miles south of San Antonio, and kept alive *for eighteen months*" at the San Pedro Springs Zoölogical Garden in San Antonio. Killed Nov. 19, 1895.

The first two specimens are similar to the series already described by me from Oklahoma (this Bulletin, VI, 1894, pp. 188, 189); the other is almost wholly white, but has the long broad tail and general proportions of the Oklahoma specimens. The whole head, except a broad median stripe and a transverse band in front of the ear, is black, as is also the whole throat and fore neck; the rest of the lower surface is white with narrow streaks and small patches of black, most prevalent toward the anal region. Above the only black on the body is a narrow median stripe extending from the middle of the back to the base of the tail, and black hairs, in ill-defined stripes over and posterior to the shoulders. The long hairs of the tail are white at base and terminally, most of them wholly white, but many have the middle third black. Of this specimen Mr. Attwater gives the following measurements: Length, 711; tail (to end of hairs), 375; tail vertebræ, 260; hind foot, 66. Weight, 3½ lbs., of which about one pound was fat.

On the skull the occipital and sagittal crests are well developed, although the animal was, from the above evidence, probably not more than two years old.

42. **Spilogale indianola** *Merriam.* INDIANOLA STRIPED SKUNK.—Two specimens, one "shot at night in the top of a mesquit tree," October 5, 1895, near the city; the other was taken on the Medina River, fifteen miles south of San Antonio. The white markings in both these specimens are pure white instead of creamy white, as is usually the case with specimens from the coast region of Texas (*cf.* this Bulletin, III, 1890, p. 219, and VI, 1894, p. 196).

"Not very common, but apparently more numerous in the rough country north of San Antonio than south of it. The Little Striped Skunks are known here as 'hydrophobia skunks.'"— H. P. A.

At my solicitation Mr. Attwater kindly made inquiries as to the evidence in support of the belief that this species is especially subject to *rabies*, and hence dangerous to human life. As the results of his inquiries, he writes later that "I have as yet no authentic accounts of persons being bitten." He heard of numerous cases, but could find no one having personal knowledge of such facts. He says: "I hear a good many 'yarns,' but as yet nothing reliable. Everybody believes their bite will cause hydrophobia, because everybody else says so, and knows some one who knew some one else that was bitten, etc., etc."

43. **Putorius brasiliensis frenatus** (*Licht.*). BRIDLED WEASEL.—One specimen, ♂ ad., San Antonio, Feb. 12, 1891. Total length, 495; tail to end of hairs, 213; tail to end of vertebræ, 186; hind foot, 51.

"Not common, but occasionally met with in the chaparral and cactus lands, where Wood Rats, Rabbits and Quail abound. They were frequently met with around San Antonio during the great 'Tramp Rat' invasion of 1889–90."—H. P. A.

44. **Taxidea taxus berlandieri** (*Baird*). MEXICAN BADGER.—One specimen, ♀ ad., San Antonio, March 2, 1895. "Weight, 14½ lbs." The white dorsal stripe runs uninterruptedly from the nose to the base of the tail, but is considerably reduced in width over the shoulders.

"Badgers are common in places between San Antonio and the Rio Grande, but it is only during the last few years that I have heard of them in this county. The female sent was killed on March 2. It was run down at night by hounds, while cat hunting, 18 miles southwest of San Antonio. Its stomach contained the remains of a Pocket Mouse, a young Wood Rat, Lizards, etc."—H. P. A.

45. Canis lupus (? **nubilis** *Say*). LOBO WOLF; TIMBER WOLF.—"Formerly common in Bexar County, but I have not heard of their occurrence here for several years. They are still found in the broken, hilly country northwest of San Antonio, particularly in Edwards County. They are more cautious than the Coyotes, and disappear as the country becomes more settled and traversed by railroads. They are much more dreaded by the sheep and goat-men than the Coyotes. Mr. Lacey says a Coyote kills sheep because he wants something to eat, but that a 'Lobo' kills them just for fun, and generally 'lays out' a dozen or two before he quits. The ranchmen always pay a larger reward for a Lobo than for a Coyote.

"Mr. J. Blackburn Miller, of Newburgh, N. Y., who spends much time hunting in Texas, with headquarters at San Antonio, and a good authority on Texas game, has made some interesting experiments crossing Coyotes and Lobos with some of his dogs. A setter bitch crossed with a male Coyote raised three pups, and a 'Great Dame' or Wulmer bitch crossed with a male Lobo had thirteen pups."—H. P. A.

Since receiving the above, Mr. Attwater has sent me clippings from a newspaper report of the Fourth Annual Convention of the 'Texas Live Stock Association,' held in San Antonio, Jan. 14, 1896. In consequense of "the alarming increase of destructive animals in this State, especially the Loafer or Gray Wolf, and the consequent loss of our stock," it was urged by Mr. Pryor, the President of the Association, that prompt action be taken to secure from the legislature a law "placing a bounty on this one class of depredators." Other speakers referred to the serious loss of stock from the ravages of Wolves and Coyotes, amounting in some instances, it was claimed, to about 10 per cent. a year.

46. Canis latrans *Say*. COYOTE.—"Coyotes are common in Bexar County, and come to the outskirts of San Antonio during the night after chickens, etc. We have been favored with a number of visits from them during the present year. In Kerr County and adjoining counties they are the 'thorn in the side,' of the sheepmen. Mr. Lacey says the Coyotes of that region are different from the Coyotes of the prairies, being much larger. They are believed by the ranchmen to be a cross between the 'Lobo' (Wolf) and the Coyote. Two years ago, when the bounty act was in force, the regular 'Lobo' price was allowed for the large Coyotes of the rocky region to the northwestward of San Antonio.

"A pair of Coyotes in the Zoölogical Garden have bred for the last four or five years. The young are generally born in April, from four to nine in a litter. The male is nearly black; the female of the ordinary color. The young are about half black and half gray, with generally more black ones than gray, *i.e.*, three out of five are black."—H. P. A.

47. **Vulpes fulvus** (*Gmel.*). Red Fox.—Mr. Attwater in his manuscript notes having made reference to the occurrence of this species in Texas, and to the fact of its probable recent introduction from the East, led me to ask for further information on the subject. With his usual readiness to supply information whenever obtainable, he wrote me under date of Dec. 18, 1895, as follows:

"Enclosed is a communication from Mr. T. H. Brown, Secretary of Texas Fox Hunters' Association, Waco, Texas, in reply to my letter to Mr. Seley, to whom I wrote asking for some information in regard to the Red Foxes, mentioned in my last letter. I trust the information will be interesting. It is certainly satisfactory to get authentic and reliable accounts of such circumstances direct from those who first introduced the animals, thereby establishing reliable data for future reference, and I am pleased to think we have been able to do so with so little trouble. You can retain the letter, as I have taken notes from it," etc.

Mr. Brown's letter here follows, and is so detailed and explicit, and so well covers the essential facts of the introduction of Red Foxes into Texas for sporting purposes, that it will take its place in the natural history literature of Texas as a document of permanent historic interest.

OFFICE OF T. H. BROWN,
County Clerk, McLennan Co.,
WACO, TEXAS, *December 9, 1895.*

H. P. ATTWATER, ESQ., San Antonio.

My Dear Sir :—I have just been handed a letter by Mr. Seley from you desiring information in regard to "Red Foxes," and will take pleasure in giving you such information as I have. Yes, sir, there is a Texas Fox Hunters' Association, with Dr. John D. Rogers, of Galveston, as President, and myself as Secretary. I was the first to introduce "Red Foxes" into this part of the State. We had exchanged our old time native hounds or, as are usually called, "Pot Lickers," for the Walker dogs from Kentucky, and the Gray Foxes proved themselves no match for these dogs, only being able to run from twenty to forty-five minutes ahead of them. Having the dogs, it became necessary to get game that would give them a respectable race. Accordingly in 1891 I imported from Kentucky and Tennessee 10 Red Foxes and placed them among the Bosque Brakes about four miles above where it empties into the Brazos River. They gradually scattered over a large area of country. The next spring (1892) I again brought in 23 more reds from the older States, planting 13 of them again among the Bosque Brakes and 10 of them on White Rock Creek on the east side of the Brazos River. These foxes afforded us some fine sport, but they too gradually scattered, only a few remaining in the neighborhood of their adopted home, some wandering off through Bosque and Erath Counties. The next spring I only succeeded in getting two reds from the East and planted these on the Bosque, and they remained and are still affording fine races. In the spring of 1895 I again planted 5 reds on the river near Lovers' Leap, where the waters of all the Bosques mingle with the waters of the Brazos. Some of the bluffs here are 300 feet high, and have a great many caves in them, and these last foxes seem well satisfied with their new home. Occasionally I hear of a Red Fox in various parts of this (McLennan) County, and I am satisfied that within a few years they will be as numerous here as in the old States.

I understand that Messrs. Eli and James Rosborough and Capt. T. H. Craig, all of Marshall, Harrison County, some ten or fifteen years since planted quite a number of reds in that, the eastern, part of the State, and occasionally they find them where they have located off some twenty or thirty miles from where originally turned loose.

Dr. John D. Rogers has, I think, during the spring of 1895, planted some six or eight on his Brazos Bottom farms in Brazos and Washington Counties. I would suppose that in all there have been at least 100 Red Foxes imported and planted in the State.

Hoping this information will assist you in your work,

I remain most respectfully,

T. H. BROWN.

48. Urocyon cinereo-argenteus (*Müll.*). Gray Fox.—"Gray Foxes are not very common, and are found generally away from the river bottoms, and in the more heavily timbered parts of the country south of San Antonio. They are perhaps more at home in the broken country north of San Antonio. They are fond of grapes, persimmons, wild cherries, black haws, etc., and are said to eat melons. They are good climbers. Mr. Lacey informs me that his hounds sometimes tree them, and that they go to the tops of the highest trees. He remembers one or two occasions when the fox was 'the highest part of the tree.'

"While we were camped out in the rough country west of Turtle Creek in Kerr County, last December, I had a good opportunity for becoming familiar with the note or noise made by these little foxes. They approached our camp-fire after dark, and from a respectful distance gave vent to their surprise or disgust. From the shape of this beautiful little animal I should certainly have expected to hear some kind of a sharp, ringing bark, like the howl of a small dog or a coyote, but was surprised to hear a hoarse kind of noise, repeated slowly several times with short intervals, more like the coarse note of some bird of prey than the bark of a fox. In fact, at first I took it to be the note of some kind of owl or night bird, with which I was unfamiliar, but Mr. Lacey was well acquainted with it."—H. P. A.

49. Lynx texensis *Allen.*[1] Texas Lynx.—Two specimens, as follows: No. 10,311, ♂ ad., Watson's Ranch, Medina River, 15 miles south of San Antonio, May 9, 1894; No. 10,310, ♂ ad. (a flat skin), same locality, Feb. 14, 1895. These specimens measure respectively as follows: No. 10,311, length, 913; tail, 190; hind foot, 190; weight, 18¾ lbs. No. 10,310, length, 935; tail, 197; hind foot, 188.

From Mr. Attwater's extended notes on this species, I extract the following:

"The Lynx, or Short-tailed Wild Cat, is common all over this region, but not as numerous as formerly. Its home is among the ravines and dry gullies which run into the creeks and rivers,

[1] *Lynx rufus*, var. *maculatus*, Aud & Bach. N. Am. Quad., II, 1851, 259, pl. xcii. (Not *Felis* (*Lynx*) *vulgaris maculatus* Kerr, An. Kingd., I, 1792, No. 297.)
Lynx texensis Allen, Bull. Am. Mus. Nat. Hist., VII, p. 188, June 20, 1895.

where the land is broken and cut into holes and fissures by heavy rains, and the whole covered with a tangled growth of thorny brush, cacti, yuccas, and small trees, forming a labyrinth which presents to the intruder a thousand thorns at every step, penetrated only by cattle paths leading to water, and where a man found traveling on foot would be considered either an escaped lunatic or a fugitive from justice. Here the Wild Cats used to share the premises with Peccaries, but the latter have been killed out in this county, and their only neighbor now is the rattlesnake.

"Wild Cats are often seen in the daytime, lying on ledges along the river bluff, and on horizontal limbs of trees sunning themselves. Mr. Watson once saw a Wild Cat lying in the water on the Medina River, cooling itself after having been run by dogs. Their food consists chiefly of Wood Rats, Rabbits and Quail. They steal many turkeys and chickens from the ranches, and kill goats and young pigs. On skinning a Wild Cat, the legs, head, neck, etc., are often found to be covered with cactus thorns, where they have accumulated under the skin in large quantities, the cats no doubt obtaining most of the rats, etc., by pouncing on them in their retreats among the bunches of *Opuntia*.

"I have had the pleasure of hunting Wild Cats with Mr. Otto Braubach, a neighbor of Mr. Watson, who has a pack of hounds trained to hunt cats, and have obtained some interesting information from him in regard to their habits. Mr. Braubach hunted Wild Cats for the bounty several years ago, and in less than twelve months, commencing about September, 1892, killed 85 of these cats. They were nearly all killed in a cattle 'pasture' formed by the fork of the Medina and Leon Rivers about twelve miles southwest from San Antonio. A number of other Wild Cats were killed during the same time by other hunters in the same neighborhood. It generally took the hounds about three hours to tire a cat out and 'tree' it or corner it in a cave, and one was once run into the river by the dogs and killed there. The cats would not take to trees or holes on *dark nights*, but kept dodging around in chaparral thicket till they were run down.

"Mr. Lacey reports them common in Kerr County, and from a high place on the side of a cañon he once saw an old one dodging the dogs by following around *after* the hounds that were trailing it among the thickets below him. These cats are often taken while young and raised as pets, and become very much attached to their owners. They occasionally breed in confinement."—H. P. A.

50. **Felis concolor** *Linn.* PANTHER; MEXICAN LION.—Represented by two skulls and a kitten, which died in the Zoölogical Garden at San Antonio.

"Not as scarce as the Jaguar in the country west of San Antonio, but they are fast becoming killed out. Mr. Otto Braubach saw one on the Medina River in this (Bexar) county two years ago, and Mr. Lacey reports one on Turtle Creek, Kerr County, one year ago. These are the only recent trustworthy records I have.

"The pair of which I sent you the skulls died here in the Zoölogical Garden from having been poisoned. They had given birth to two litters of kittens, of four each—the first, April 4, 1891, the second, June 4, 1892. The period of gestation was observed to be 96 days. They were about six years old."—H. P. A.

51. **Felis onca** *Linn.* JAGUAR.—"Rare east of the Nueces River, but still taken occasionally in the chaparral thickets in the counties bordering the Rio Grande. Said to have formerly occurred in this (Bexar) county."—H. P. A.

52. **Felis pardalis** *Linn.* OCELOT; LEOPARD CAT.—"Common in the vast chaparral thickets between San Antonio and the Rio Grande, but now seldom discovered near San Antonio. Three years ago Mr. Otto Braubach's hounds treed a Leopard Cat near the fork of the Medina and Leon Rivers. This is the only recent authentic record I have for the occurrence of this animal in Bexar County. Mr. Lacey informs me that they are still met with rarely in Kerr County."—H. P. A.

The following species was accidentally omitted in its proper place (p. 57).

53. **Lepus aquaticus attwateri** *Allen.* ATTWATER'S SWAMP HARE.

Lepus aquaticus attwateri ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 327. (Published Nov. 10, 1895.)

There is nothing to add to the account of this species already published (l. c.).

Article VI.—SPECIES OF HYRACOTHERIUM AND ALLIED PERISSODACTYLS FROM THE WAHSATCH AND WIND RIVER BEDS OF NORTH AMERICA.

By J. L. Wortman.

Plate II.

The determination of the species of the Perissodactyla from the Lower Eocene horizons of this country has hitherto been a matter of considerable difficulty, and it has been only after a most careful study of nearly all the known material, that I have been able to come to any definite conclusions regarding their classification and arrangement. At the outset it is necessary to clearly distinguish the genera before undertaking to discuss the species.

In the Wahsatch deposits of this country there are only three genera which clearly belong to the Perissodactyla, although several others have been described. The three well-marked groups of species thus capable of being distinguished and defined are *Heptodon*, *Systemodon* and *Hyracotherium*, all of which are found associated in the same deposits. Three others have been proposed, but it is highly probable that they are either synonyms of one of the three above mentioned, or of doubtful generic value.

Of these latter invalid genera I will consider first the one proposed by Prof. Marsh[1] under the name *Eohippus*, to which he refers two species, *E. validus* and *E. pernix*, the former from the Wahsatch of New Mexico, and the latter from the Wahsatch of the Bear River Beds of western Wyoming. Zittel[2] considers *Eohippus* and *Ectocium*, a genus proposed by Cope from the Wahsatch of the Big Horn Basin, as synonymous, but upon what

[1] Amer. Jour. Sci., Vol. XII, Nov., 1876, p. 401.
[2] 'Handbuch der Paleontologie,' p. 242.

ground he does not state. From Prof. Marsh's description and measurements of the two species of this genus it would appear, at least until some other differences are shown to exist, that *Eohippus validus* is the same as *Hyracotherium vasacciense* of Cope from the same locality. *Eohippus pernix*, according to the measurements and description, corresponds exactly with *Hyracotherium index* of Cope, also from the same locality in which Prof. Marsh's specimen was obtained.

Prof. Marsh has, however, added some important knowledge to the characters of these earliest known horses, more especially as regards the structure of the feet. He has shown,[1] for example, that in *E. validus* the hind foot possessed a vestige of the fifth digit, a structure which had entirely disappeared from the horses of the Wind River Beds. He was the first, moreover, to point out the equine characters of these forms. The question now arises, what is the foot structure of the type of *Hyracotherium?* If it is the same as that described by Marsh in *Eohippus validus*, then *Eohippus* is a *synonym* of *Hyracotherium*, but if it is the same as that described by Cope in *Hyracotherium venticolum*, viz., the absence of this vestigial fifth digit, then the genus *Eohippus* is a good one and must be retained. The only characters upon which we are enabled to form a judgment is the structure of the superior premolars. These in Owen's type of *Hyracotherium*[2] are simple, and correspond closely with the Wahsatch stage of evolution in this country. While in the Wind River horizon, as I will attempt to show presently, there is a decided advance in the structure of one of these teeth, at least, which we know is associated with the disappearance of the vestigial fifth digit from the hind foot, as exemplified in the skeleton of *Hyracotherium venticolum*. From this evidence it seems to me that one is in a measure justified in considering *Eohippus* and *Hyracotherium* as referring to one and the same group of species. There is, however, a constant and important difference between the European and American Hyracotheres seen in the structure of the second superior premolar. In all the American forms which I have seen this tooth has two

[1] Amer. Jour. Sci., Vol. XII, Nov., 1876, p. 401.
[2] Trans. London Geolog. Soc., 2d Series, Vol. VI, p. 203, pl. xxiv.

external cusps, whereas in the European species it is always single, and is therefore more primitive.

I leave for the present the discussion of the propriety of removing those Wind River forms, which exhibit this advanced structure of the premolars and the loss of the vestigial fifth digit, from the genus *Hyracotherium* or *Eohippus*, and giving to them an independent rank of equal generic value.

The next genus to be considered is *Ectocium*, which was originally proposed by Prof. Cope.[1] A careful comparison by Prof. Osborn of the type specimen with some of the smaller species of *Phenacodus* reveals the fact that it undoubtedly pertains to this, or some nearly related genus, and is not a member of the Perissodactyla at all.

The third genus to be considered in this connection is the so-called *Pliolophus*, which is not uncommon in the Wahsatch Beds of the Big Horn Basin. The only character by which it is known to differ from the cotemporary Hyracotheres is the presence of a fourth cusp upon the inner posterior part of the last lower premolar, whereby it is said that this tooth is molariform. According to Earle,[2] who has recently examined Owen's type, *P. vulpiceps*, in the British Museum, the last lower premolar is not entirely molariform. This is really the condition of the majority of the specimens in the American Museum collection which have been referred to this genus, although it is proper to state here that one can find almost every intermediate stage between the complete absence and the presence of a well-defined cusp in this situation. On this account I am inclined to regard this cusp as at most but a subgeneric variation.

Turning now to the three well-established genera from this formation, I will consider first the characters by which they are distinguished from each other. These characters are summarized in the following table.

[1] Proc. Amer. Phil. Soc., 1881, p. 182.
[2] American Naturalist, Feb., 1896, p. 132.

TABLE I.—GENERA OF WAHSATCH PERISSODACTYLA.

Systemodon.	*Heptodon.*	*Hyracotherium.*	Sub. gen. *Pliolophus* (?)
(1) 1st superior premolar, either separated by diastema from 2d premolar or teeth in continuous series.	(1) 1st superior premolar always in contact with 2d premolar and separated by diastema from canine.	(1) 1st superior premolar separated by diastema from both canine and 2d premolar.	(1) Same as in *Hyracotherium.*
(2) Internal cusps of superior premolars composed largely of single oblique crest, directed forwards and inwards. Outline of crown triangular. No intermediate cusps.	(2) Same as *Systemodon.*	(2) Internal cusps of superior premolars composed of large lunate cusp, with tendency to divide into two cusps. Outline of crown more or less quadrate. Intermediate cusps present.	(2) Same as in *Hyracotherium.*
(3) Superior molars with intermediates not distinct, but confluent with internal cusps, forming distinct crests. Posterior external cusps very little flattened externally and little pushed inwards; cross crests low and obtuse.	(3) Superior molars with intermediates completely fused into cross crests. Posterior external cusps flattened externally and much pushed inwards. Cross crests high and cutting.	(3) Superior molars with intermediates not fused with internal cusps into cross crests, but distinct and well separated. Postero-external cusps not flattened externally nor pushed inwards.	(3) Same as in *Hyracotherium.*
(4) 1st inferior premolar in contact with canine and separated by diastema from 2d premolar, or (?) in contact with 2d premolar and separated from canine by diastema.	(4) 1st inferior premolar in contact with 2d premolar and separated by diastema from canine.	(4) 1st inferior premolar separated by diastemata from both canine and 2d premolar.	(4) Same as in *Hyracotherium.* In one species diastema absent.
(5) Inferior molars with imperfect cross crests notched in centre, connected fore and aft with an oblique ridge. Heel of last molar large.	(5) Inferior molars with perfect cross crests not notched in centre, nor connected by fore and aft oblique ridge. Heel of last molar reduced.	(5) Inferior molars without or with slightly developed cross crests, connected by oblique ridge, as in *Systemodon.* Heel large. Last inferior premolar with single posterior cusps.	(5) Same as in *Hyracotherium*, except last inferior premolar with two posterior cusps.
(6) Digits, ?–4.	(6) Digits, 4–3.	(6) Digits, ?–4.	(6) Digits, ?–3.

Heptodon *Cope.*

This genus, which is first met with in the Wahsatch and continues in the Wind River Beds, marks the beginning of an important phylum, whose greatest development occurred in the later Bridger and Uinta epochs in America. It is a near relative of *Lophiodon*[1] of the Eocene of Europe, and indeed Cope, who originally proposed the genus, spoke of it as a *Lophiodon* with a full complement of premolars in the upper jaw, whereas *Lophiodon* proper has the first premolar missing.

It differs from its undoubted successor in the Bridger formation, *Helaletes*, in having all the premolars simpler than the molars, while this latter genus has two of the premolars submolariform.

The distinctions between it and *Systemodon*, its Wahsatch cotemporary, while not marked by any very pronounced characters, is still sufficiently clear to fully warrant the generic separation of the two groups. The more important of these characters are as follows: In *Systemodon* the superior premolars and canine either form a continuous series or the first premolar is separated from the second by a diastema, being in contact with the canine. In *Heptodon* the first premolar is always in contact with the second, and there is a considerable diastema between it and the canine. In the superior molars *Systemodon* has rather low obtuse cross crests, while in *Heptodon* these cross crests are much higher, sharper and generally better defined. The postero-external cusps (metacones) of the molars of *Heptodon* are considerably flattened externally and pushed inwards, whereas in *Systemodon* they are pushed but little inwards and are convex externally. In *Heptodon* again the first inferior premolar is in contact with the second, and is separated by a diastema from the canine, whereas in *Systemodon* the first inferior premolar is in contact with the canine and separated by a diastema from the second. It should be stated, however, that the lower jaw of two of the species of *Systemodon* is not known with certainty as regards this character, but from some fragmentary material of *Systemodon semihians* it seems probable that the first lower premolar is placed as in the species of *Heptodon*. I have, therefore, used this character only provisionally. Some further differences are to be seen in the

[1] See Bull. Am. Mus. Nat. Hist., Vol. VII, 1895, p. 361.

lower teeth which serve to distinguish the two genera from each other quite clearly. The cross crests of the lower molars of *Systemodon* are less perfectly developed, and the anterior and posterior crests are always connected longitudinally by an oblique ridge; in *Heptodon* the cross crests are better developed, just as in the superior molars, and the oblique fore and aft ridge is entirely wanting. In *Heptodon*, moreover, the heel of the last molar is much reduced and pointed, while in *Systemodon* it is large, broad and prominent. This reduction of the heel, I take it, is in some way associated with the pushing in of the metacone and shortening of the posterior cross crest of the last superior molar, which is always most pronounced in this tooth, indicating its remote affinity to the Rhinocerotoidea.

As compared with *Hyracotherium*, the position of the first superior premolar in both jaws, the internal cusps of the superior premolars, as well as the structure of the molars, distinguish *Heptodon* at once from this genus. These characters are fully set forth in the foregoing table and need no further mention.

The species of *Heptodon* are not numerous, two having been described by Cope from the Wahsatch and two from the Wind River Beds; one of these, *H. singularis*, is as yet very imperfectly known, and it may prove to belong to another genus. It is from the Wahsatch of New Mexico. The other Wahsatch species, *H. posticus*, is represented by two lower jaws from the Big Horn Beds (Nos. 4687 and 4688), while the two Wind River species, *H. calciculus* and *H. ventorum*, are better known.

The definitions of these species are as follows :

H. posticus Cope.[1]	*H. calciculus* Cope.[2]	*H. ventorum* Cope.[3]	*H. singularis* Cope.[4]
(1) Upper teeth unknown.	(1) 2d upper premolar with single external cusp.	(1) 2d upper premolar with two external cusps.	(1) 2d upper premolar unknown.
(2) 4th lower premolar with single posterior cusp.	(2) 4th lower premolar same as in *H. posticus*.	(2) 4th lower premolar with two posterior cusps.	(2) Lower teeth unknown.
(3) Length of 3 lower molars and 3 lower premolars, 62 and 66 mm.	(3) Length of 3 lower molars and 3 lower premolars?	(3) Length of 3 lower molars and 3 lower premolars?	(3) Unknown.
(4) Upper molars unknown.	(4) Length of upper molars and 3d and 4th premolars, 48 mm.	(4) Length of upper molars and 3d and 4th premolars, 47 mm.	(4) Length of upper molars and 3d and 4th premolars, 32 mm.

[1] Proc. American Philos. Soc., 1881, p. 187. Am. Nat., 1882, p. 1029.
[2] Am. Nat., 1880, p. 747. [3] Am. Nat., 1880, p. 747. [4] Wheeler Surv., IV, ii, pl. lxvi.

As already remarked, the larger Wahsatch species, *H. posticus*, is known from two lower jaws, which differ somewhat from each other in size. The smaller of these (No. 4688) Cope referred to *H. ventorum*, but it differs from this species not only in the simpler fourth premolar of the lower jaw, but in the less elevated and more obtuse crests of the molars. From *H. calciculus* it differs, so far as we now know, only in size, but, considering the wide separation in point of time, there can be little doubt that other important differences will be found when we know more of its skeleton. For a fuller description of the Wind River species I must refer the reader to Prof. Osborn's paper[1] as well as the work of Prof. Cope.[2]

Systemodon *Cope.*

The species of this genus have thus far been found only in the Wahsatch. The distinctions between it and *Heptodon* have already been fully considered. Its morphological position, so far as I am able to judge from the fragmentary material by which it is represented, is intermediate between that of *Heptodon* and *Hyracotherium*. With the exception of the position of the

Fig. 1.

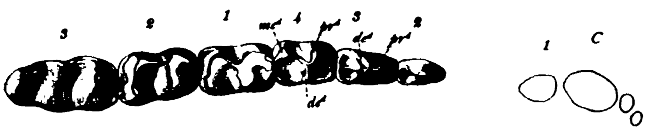

Fig. 2.

Figs. 1 and 2. *Systemodon protapirinus.* Type specimen, No. 4460, Wahsatch Beds, Big Horn, Wyoming. Natural size.

Fig. 1. Upper teeth, crown view. ABBREVIATIONS: *pr.* = protocone, *de.* = deuterocone, *tr.* = tritocone, *ps.* = parastyle.

Fig. 2. Lower teeth, crown view. ABBREVIATIONS: *prd.* = protoconid, *ded.* = deuteroconid, *med.* = metaconid.

[1] Bull. Amer. Mus., Vol. IV, Oct., 1892, p. 128, in which the foot structure of *H. calciculus* is described.

[2] Tertiary Vertebrata, p. 656.

first lower premolar, it exhibits all the characters which we would be led to look for in the ancestor of *Heptodon*. This latter character, it is proper to remark, is not known with certainty except in one species, and it may yet prove that one of the other species fulfills all the requirements of the ancestral species.

Systemodon differs from *Hyracotherium* in the following characters: In *Hyracotherium* the first premolar in both jaws is separated by a diastema from the canine in front and the second premolar behind; in *Systemodon*, as we have already seen, it varies with the species. The internal cusps of the superior premolars in *Systemodon* consist of oblique crests without intermediates, while in *Hyracotherium* these cusps are large and lunate, with a tendency to divide into two, always associated with intermediates in some of the premolars. In *Hyracotherium* the outline of the crowns of the third and fourth premolars are more quadrate than in *Systemodon*, because of the large lunate internal cusp. In the upper molars of *Systemodon*, the intermediates are fused with the internal cusps, so as to form cross crests, while in *Hyracotherium* the intermediates are perfectly distinct. The same cresting of the lower molars is seen in *Systemodon*, but while some species of *Hyracotherium* show a marked tendency in this direction they are never so fully crested as in *Systemodon*.

In the foregoing table of the generic characters, mention has been made of the foot structure of the several genera. This is well known in *Heptodon*[1] and *Hyracotherium*, but that of *Systemodon* has hitherto been unknown. I will merely mention here that so far as the hind foot is concerned, *Systemodon* resembles *Heptodon* to a remarkable extent. This likeness is seen in the compressed elongated character of the foot as well as in the great length and slenderness of the phalanges. In *Hyracotherium* the phalanges are short, a character which distinguishes them at a glance. In *Systemodon* there was at least a vestige of a fifth digit, and so far as one is able to judge from the material, I am inclined to the opinion that this digit was complete.

Three species are known with certainty, all of which are from the Wahsatch. They are defined as follows:

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[1] Bull. Am. Mus. Nat. Hist., Vol. IV, 1892, p. 128.

S. protapirinum,[1] sp. nov.	*S. primævus*, sp. nov.	*S. semihians* Cope.
(1) Premolars and canine in continuous series in upper jaw.	(1) Premolars and canines in continuous series in upper jaw.	(1) A diastema between 1st and 2d superior premolars.
(2) Second superior premolar with strong internal cusps.	(2) Second superior premolar without internal cusp.	(2) Second superior premolar with small internal cusp.

Systemodon primævus, sp. nov.

This species is indicated in the collection by two fragments of skulls (Nos. 144, 147) supporting the entire superior dentition. There are several other skull fragments in the collection which doubtless pertain to the same species, but the characteristic second premolar is not sufficiently preserved to determine this point with certainty.

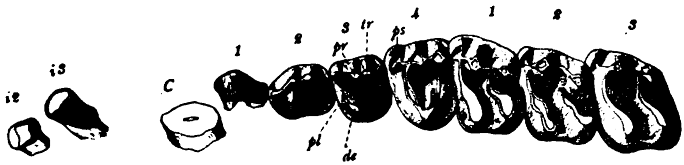

Fig. 3. *Systemodon primævus*. Upper teeth, crown view (type specimen, No. 144). Wahsatch Beds, Big Horn, Wyoming. Natural size. ABBREVIATIONS: *pr.* = protocone, *de.* = deuterocone, *tr.* = tritocone, *pl.* = paraconule, *ps.* = parastyle.

The specimen which I select as the type of the species is No. 144; it includes the two superior maxillaries and premaxillaries containing all the teeth. The structure of the superior molars and premolars, as well as the absence of diastema, refer it to *Systemodon* without question.

As compared with *S. protapirinum* it exhibits the same size and otherwise resembles it closely in every way except in the structure of the second superior premolar. In *S. primævus* this tooth has no internal cusp, whereas in *S. protapirinum* there is a strong internal cusp. From *S. semihians* it is readily distinguished by the presence of a considerable diastema between the first and second superior premolars in this latter species.

[1] The type of this species was originally referred to *Hyracotherium*, and afterwards to *Systemodon*. I find that the original generic reference was correct, and that this species requires a new name, which I here give to it.

The principal measurements are as follows :

	MM.
Length of premolar and molar series	63
Length of premolars	32

A fairly well-preserved specimen of a hind foot (No. 234) of a species of *Systemodon* is preserved in the collection, which it is proper to describe in this connection.[1] Although it is accompanied with nearly all the teeth of the lower jaw, the characteristic parts of the upper jaw are not preserved, the only means known at present by which the species can be determined with certainty. The lower jaw agrees very closely with that of *Systemodon protapirinum*, and it is highly probable that the specimen belongs to this species.

The general character of the foot is strikingly like that of *Heptodon;* this is especially seen in its comparative slenderness, the form of the astragalus, the calcaneo-fibular facet, the elongated metapodials, and above all in the extreme length and slenderness of the phalanges. As has already been shown[2] the astragalus and calcaneum of *Heptodon* are so very decidedly equine in appearance that it is indeed difficult to distinguish them at first sight in the three genera. There is a character, however, which was originally pointed out by Prof. Osborn,[3] viz. : the union or confluence of the ectal and sustentacular facets of the astragalus in all the Perissodactyla with the exception of the horses, which I find holds good in the Perissodactyla of the Wahsatch. *Heptodon* and *Systemodon* agree in having these facets confluent, while in the horses these facets are separated from each other.

The relations of the tarsal elements are very similar to those of *Heptodon*, as are also the characters of the bones themselves. One point of especial interest is the number of digits. Besides the usual three, the fourth metapodial exhibits a well-marked facet upon the posterior surface of its proximal end, which undoubtedly served for the articulation of the fifth metapodial. It may be that this metapodial was only vestigial in character, a

[1] Mention of this specimen has already been made in a former paper in the Museum Bulletin. See Art. XI, Vol. V, p. 170.

[2] Bull. Amer. Mus., Vol. IV, Article XI, 1892, p. 128.

[3] Mammalia of the Uinta Formation.

fact which would seem to be indicated by its having lost all connection with the cuboid. The exact length of the metapodials cannot be determined on account of their damaged condition, but enough is indicated to state that the foot was relatively long and slender. Several phalanges are preserved, and, as already remarked, their chief peculiarity consists in their great length. No ungual phalanges are known.

Hyracotherium *Owen.*

The differences between this genus and its two Wahsatch cotemporaries, *Systemodon* and *Heptodon*, have already been considered ; it now remains to compare it with its successors in the Wind River and Bridger epochs. I have already called attention to the fact that certain of the Wind River forms show a marked advance in the structure of the third superior premolar, which we know to be associated with the loss of the vestigial fifth digit in the hind foot. This conclusion, it may be stated, is not based upon a single specimen, but upon at least two, in which it can be determined with certainty (Nos. 4832 and 4848). We have then two trenchant morphological characters, modifications which point strongly in the direction of the subsequent changes which the horses underwent in later times.

According to all customs of palæontological nomenclature the Wind River type exhibiting these characters should be separated as a distinct genus, and although it may seem unwise to still further complicate the already overcrowded list of generic names for these early horses, yet I am strongly of the opinion that it is really necessary if we wish to truly express with our nomenclature the major and minor changes to which this steadily advancing phylum was subjected.

Additional characters which distinguish the more advanced Wind River species from the Wahsatch forms are seen in the subcrescentic form of the outer cusps of the superior molars, as well as the lengthening of all the cusps of these teeth, the presence of a rudimentary mesostyle and the appearance for the first time of a small but distinct hypostyle. Upon these characters, therefore, I propose a new genus, which may be known as *Protoro-*

hippus. The Eocene genera of the American Equidæ may then be defined as follows :

TABLE II.—GENERA OF AMERICAN EOCENE HORSES.

Hyracotherium. (*Eohippus.*) (Wahsatch.)	*Protorohippus,* gen. nov. (Wind River.)	*Orohippus.* (*Pachynolophus*) (Bridger.)	*Epihippus.* (Uinta.)
(1) A vestige of the fifth digit in the hind foot.	(1) No vestige of the fifth digit in the hind foot.	(1) Same.	(1) Same.
(2) Outer cusps of superior molars subconic.	(2) Outer cusps of superior molars subcrescentic.	(2) Outer cusps of superior molars subcrescentic.	(2) Same.
(3) No trace of mesostyle.	(3) Rudimental mesostyle.	(3) Mesostyle complete.	(3) Same.
(4) No trace of hypostyle.	(4) Rudimental hypostyle usually present.	(4) Hypostyle stronger.	(4) Hypostyle well developed.
(5) Third superior premolar with three well developed cusps and only a trace of the fourth cusp.	(5) Third superior premolar with four well-developed cusps. Second superior premolar with external cusp.	(5) Third and fourth superior premolars molariform. Second superior premolar tritubercular, with an internal cusp.	(5) Third and fourth superior premolars molariform. Second superior premolar submolariform.

I have here used the names *Orohippus* and *Pachynolophus* as possibly synonymous, as has been done by Zittel and Osborn. I do not know the type of *Pachynolophus*, and it is apparently not at all certain to what species it was originally applied. If Rütimeyer has correctly referred his specimen of an upper jaw to *Pachynolophus siderolitícus*, or if Kowalewsky has properly identified and figured the upper molars and premolars of *Pachynolophus desmaresti*,[1] then it would seem certain that the course of the evolution of the superior premolars has been very different in the European and American species of the corresponding stage of development, and that these two series represent

[1] See Zittel's 'Handbuch der Paleontologie' for figures of *P. siderolitícus* and *P. desmaresti*, p. 242, 243.

distinct phyla. If this supposition is true, then the genus *Pachynolophus*, as understood by European authors, does not occur in the Eocene deposits of this country, and its corresponding stage of evolution among the American horses is represented by the genus *Orohippus* of Marsh.

GEOLOGICAL DISTRIBUTION OF THE HYRACOTHERES.

	WAHSATCH.			WIND RIVER.	BRIDGER.	UINTA.
	N. Mex.	Big Horn.	Bear River			
Hyracotherium cristatum		×				
" vasacciense	×	×				
" tapirinum						
" craspedotum				×		
" index	×	×	×			
H. (Pliolophus) cristonense	×	×				
" montanum		×				
Protorohippus venticolum				×		
Orohippus					×	
Epihippus						×

The discrimination of the species of *Hyracotherium* is indeed a difficult task, owing partly to the very imperfect specimens that were used by Cope as types in the original descriptions of the species, and partly to the wide limits of individual variation that must be admitted in these forms. My own specific determinations are based upon the materials contained in the American Museum collections, together with the types of Cope's species from the Wahsatch of New Mexico, preserved in the National Museum. Unfortunately I have not been able to include Prof. Marsh's material from the New Mexican and Wyoming Wahsatch, but as he has described only two species from this horizon, already alluded to above, I feel reasonably certain that the more important modifications are included in the subjoined table. The characters of the species are as follows:

TABLE III.—SPECIES OF WAHSATCH AND WIND RIVER HYRACOTHERES.

H. tapirinum Cope.	*H. cristatum,* sp. nov.	*H. craspedotum* Cope.	*H. vasacciense* Cope.	*H. index* Cope.
(1) Length of third and fourth premolars and lower molars, 49 mm.	(1) Length of third and fourth premolars and lower molars, 49.5 mm.	(1) Length of third and fourth premolars and lower molars, 49 mm.	(1) Length of molars and third and fourth lower premolars, 38 mm.	(1) Length of third and fourth premolars and lower molars, 38, 36, 32 and 31 mm. (type).
(2) Third lower premolar with two anterior cusps.	(2) Third lower premolar with single anterior cusp.	(2) Third lower premolar with two anterior cusps.	(2) Third lower premolar with single anterior cusp.	(2) Third lower premolar with two anterior cusps.
(3) Heel of last lower molar small; tooth relatively short and broad.	(3) Heel of last lower molar large; tooth long and narrow.	(3) Heel of last lower molar large; tooth relatively broad.	(3) Heel of last lower molar small; tooth relatively short and broad.	(3) Heel of last lower molar large; tooth long and narrow.
(4) Posterior cusps of last lower molar separated by deep notch.	(4) Posterior cusps of last lower molar connected by cross crest.	(4) Posterior cusps of last lower molar separated by deep notch.	(4) Same.	(4) Same.

Hyracotherium tapirinum[1] *Cope.*

Systemodon tapirinum.

This is one of the largest species of all the Wahsatch Hyracotheres. It was originally described by Cope from the Wahsatch of New Mexico from two fragments of lower jaws. One of these (1064, Nat. Mus. Coll.) contains the last two molars, but is in such a very worn and damaged condition as to be practically valueless for the determination of the characters of the species. A second fragment (1083, Nat. Mus. Coll.), containing the second molar in a good state of preservation however, shows the characters much better, and demonstrates beyond any doubt that it belongs to *Hyracotherium* and not to *Systemodon*, as Cope afterwards concluded, and has subsequently referred it. Additional material, including nearly all the upper and lower teeth with the exception of the upper and lower incisors and canines, is

[1] Cat. Eoc. Vert. New Mexico, 1875, p. 20. Amer. Nat., 1881, p. 1018. Tert. Vertebrata, p. 619 (referred to *Systemodon*).

now contained in the collections of the Museum, which permit of a fuller determination of the species.

These materials are (1) a fragment of lower jaw supporting the last two molars (No. 143*a*); (2) upper and lower molars of both sides, together with lower premolars 3 and 4, and the fourth upper premolar (No. 4657); (3) a palatal portion of a skull containing all the molars, together with the third and fourth premolars (No. 212); and (4) upper and lower molars associated with second superior premolar (No. 139). Since no one specimen gives all the characters of the dentition, the accompanying drawing has been constructed from these several specimens.

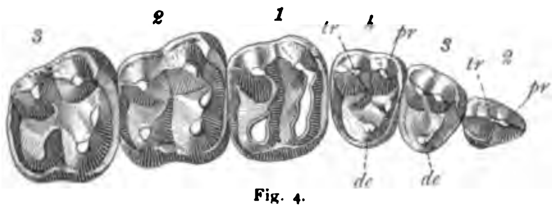

Fig. 4.

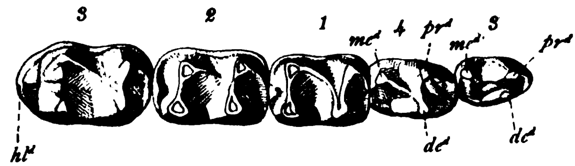

Fig. 5.

Figs. 4 and 5. *Hyracotherium tapirinum.*

Fig. 4. Upper teeth, crown view (composition from Nos. 139 and 212). Wahsatch, Big Horn. × ⅓.

Fig. 5. Lower teeth, crown view (composition from Nos. 143*a* and 4647). Wahsatch, Big Horn. × ⅓.

ABBREVIATIONS: *pr.* = protocone, *de.* = deuterocone, *tr.* = tritocone, *prd.* = protoconid, *ded.* = deuteroconid, *med.* = metaconid, *hld.* = hypoconulid.

The *characters of the species* are as follows: Species large; the length of the lower molars and premolar 3 and 4, 49 mm. The heel of the last lower molar is relatively small and conic, and the cross crests are well developed with the exception of that connecting the two posterior cusps of the last molar, which are separated by a deep notch. The second lower premolar has a well-developed second anterior cusp. The antero-internal cusps of the lower molars are not bifid at their extremities. In the upper molars the intermediates are hardly as distinct as in some of the smaller species; the fourth superior premolar has very distinct intermediates, and the second displays two distinct external cusps. The measurements of the teeth are as follows:

		MM.
Length of	the 3d and 4th premolars and three lower molars	49
"	last lower molar	13
"	molars 1 and 2	21
"	3d and 4th lower premolars	15
"	upper molars and premolars 2, 3 and 4	51
"	upper molars	32
"	upper premolars 2, 3 and 4	19

The species is so far known from the Wahsatch of New Mexico and the Big Horn Basin, Wyoming. The specimens referred to it are Nos. 139, 143*a*, 212, 4598, 4650, 4651, and 4657.

Hyracotherium cristatum, sp. nov.

This large species of *Hyracotherium* is represented in the collection by five or six specimens from the Wahsatch of the Big Horn Basin. It is about equal in size to *H. tapirinum*, but differs from it markedly in the structure of the third lower premolar, which lacks the antero-internal cusp. The antero-internal cusp of the fourth premolar is also much less developed, and has a

Fig. 6. *Hyracotherium cristatum*. Lower teeth, crown view (composition from Nos. 240 and 248B, Type specimens). Wahsatch Beds, Big Horn. X ⅔.

more posterior position than in *H. tapirinum*. The heel of the last molar is relatively much larger, the cusps are more elevated, and the antero-internal cusps of the lower molars are slightly bifid. The cross crests of the lower molars are well developed, that between the posterior cusps of the last molar being as well developed as the others.

Two superior molars associated with lower molars are contained in the collection, which serve to demonstrate that it belongs to *Hyracotherium* and not to *Systemodon*, as the extreme cresting of the lower molars would seem to indicate. The superior premolars are unknown. The measurements are as follows :

	MM.
Length of 3d and 4th lower premolars and molars	49.5
" last lower molar	14.5
" molars 1 and 2	20
" premolars 3 and 4	15

The *type* of this species consists of two specimens, one (No. 258*b*) a fragment of a lower jaw bearing the first and second molars, and the third and fourth premolars, and another, a fragment of a lower jaw (No. 240) containing the last molar; both from the Wahsatch of the Big Horn Basin. To it may also be referred Nos. 4653–6, from the same locality.

Hyracotherium craspedotum[1] *Cope.*

Cope's *type* of this species consists of a lower jaw (No. 4830), one side containing the three molars and a part of the last premolar, the other side containing premolars 2 and 4 with the first molar, from the Wind River Basin. There is also a skull (No. 4831) in the collection from the same horizon which contains nearly all the upper teeth with the exception of the incisors and canines; notwithstanding that it is somewhat smaller than the type it has been referred to the same species.

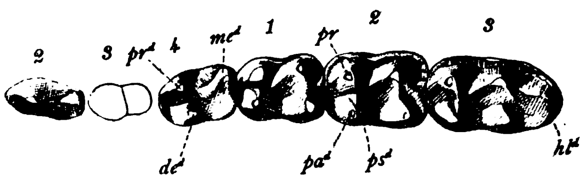

Fig. 7. *Hyracotherium craspedotum.* Lower teeth, crown view (type specimen, No. 4830). Wind River Beds, Wyoming. X 3/2.

The characters of this species indicate that it is closely related to, and very probably the direct successor of, *H. tapirinum* of the Wahsatch. Unfortunately the third lower premolar is not preserved, so it is impossible to say whether it agrees with *H. cristatum* or *H. tapirinum* in the structure of this tooth. It is more than probable, however, that it will be found to agree with

[1] Amer. Nat., 1880, p. 747 ; Tert. Vert., p. 631.

the latter of these species in this character, since the presence of this antero-internal cusp constitutes an advance in the structure of the premolars, and it would be remarkable indeed if a Wind River species were so backward in this particular as to have this cusp lacking.

It differs considerably from *H. tapirinum* in the size of the heel of the last lower molar, which is large, and inclined to be more or less basin-shaped. It also differs from this species in having a much greater width of the lower molars in proportion to their length. The extreme, among the large species, of the long and narrow lower molars is seen in *H. cristatum.* The cusps of the lower molars of the species under consideration are low and obtuse, and the cross crests are but very little developed—an additional character which distinguishes it sharply from *H. cristatum.* The antero-internal cusps of the lower molars are slightly bifid at their extremities, presenting a parastylid. The superior molars do not present any differences worthy of note from those of *H. tapirinum.*

The measurements are as follows:

	MM.
Length of 3d and 4th premolars and lower molars..........	49
" last lower molar..................................	14
" molars 1 and 2.......	19.5
" premolars 3 and 4..........................	15.5
" superior molars and 3d and 4th premolars.......	42

Hyracotherium vasacciense[1] *Cope.*

The *type* of this species consists of a single lower molar (No. 4658) from the Wahsatch of New Mexico, which I take to be the

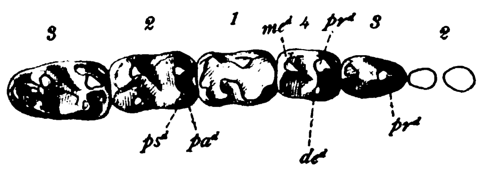

Fig. 8. *Hyracotherium vasacciense.* Lower teeth, crown view (No. 4659). Wahsatch Beds, Big Horn Valley, Wyoming. X ½.

[1] Proc. Am. Phil. Soc., 1872, p. 474; Tert. Vert., p. 634.

second. It is wholly uncharacteristic, and the reference of any additional material to it is, according to the very nature of the case, attended with uncertainty. Cope subsequently obtained other material more characteristic which he referred to this species,[1] and distinguished the species by the depth of the ramus. This character I find is exceedingly variable, and appears to be in a large measure dependent upon the age of the individual. If we are to accept Cope's determinations, then, in my judgment, the species will have to be abandoned, since there are no means discoverable, with the present material at least, by which it can be distinguished from *H. index*. There is in our collection from the Big Horn an almost complete jaw (No. 4659) containing all the molars, together with the third and fourth premolars, which I prefer to take as representing this species. I do this for three reasons, viz.: (1) It agrees quite as well with the uncharacteristic type as does any other specimen which has been referred to it; (2) by so considering it the species is capable of definition, and (3) the proposing of a new specific name will be avoided.

The *character of the species* thus considered would then be as follows: The ramus is remarkable for its great depth in comparison with the size of the teeth; the third lower premolar is without the antero-internal cusps; the last lower molar is unusually short and broad with a relatively small heel. The measurements are:

	MM.
Length of 3d and 4th premolars and lower molars	38
" last lower molar	10
" molars 1 and 2	15
" premolars 3 and 4	13

Beside those already mentioned, two other individuals, Nos. 4660 and 4661, are referred to this species.

Hyracotherium index[2] *Cope.*

Under this heading I arrange all the specimens which Cope has referred to *H. index*, *H. angustidens*, *H. cuspidatum*, all, in fact,

[1] Wheeler Surv. Rep., Vol. IV, Part ii, p. 264.
[2] Bull. Hayden Surv., 1873, p. 459; Wheeler Surv. Rep., IV, Pt. ii, p. 262; Tertiary Vert., p. 650.

except the type, which he has referred to *H. vasacciense*, as well as all the *Wahsatch* specimens classified under the name of *H. venticolum*. I also place here Cope's specimens identified as *Orotherium vintanum* (Marsh) from the New Mexican Wahsatch. The

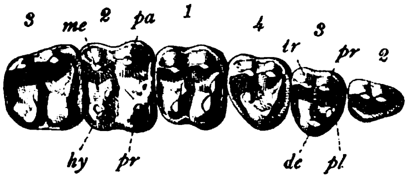

Fig. 9.

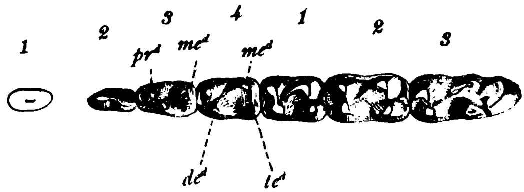

Fig. 10.

Figs. 9 and 10. *Hyracotherium index.*

Fig. 9. Upper teeth, crown view (No. 4602). Wahsatch Beds, Big Horn Valley, Wyoming.
Fig. 10. Lower teeth, crown view (No. 4613). Wahsatch Beds, Big Horn. X ⅓.

type of this latter species was originally described by Marsh from specimens found on Henry's Fork in the Bridger Basin, and it is very much more probable that it belongs to *Orohippus* than to *Hyracotherium*.

In bringing together all of these so-called species I am sensible of the fact that it associates individuals which differ from each other considerably in the matter of size and the depth of the ramus, but there are such perfect gradations in this respect among the large number of individuals which we now possess, that I find it utterly impossible to make any valid distinctions, and it is perhaps better to err on the side of safety and have too few species than to admit a larger number which cannot be defined.

The species thus constituted exhibits a very great constancy in the structure and proportions of the teeth, from which it is almost exclusively known. The *specific characters* may be summarized as follows: The third lower molar is very long and narrow in proportion to its width; the heel is large, prominent, and has but a single pointed cusp. The cusps of the lower molars are well separated, with very little tendency to form crests, and the third lower premolar has two anterior cusps. There is a very considerable difference in size, together with marked differences in the depth of the mandibular ramus, but, as already remarked, this latter character is in some measure due to the age of the individual.

The species is at once distinguished from *H. vasacciense* and *H. cristatum* by the more complex character of the third lower premolar; from *H. tapirinum* it differs not only in size, but in the much narrower and relatively longer last molar, the relative size of the heel of this tooth, and the degree of separation of the cusps of all the lower molars. From *H. craspedotum* it can readily be distinguished by the much smaller size, and the general narrowness of the lower teeth in proportion to their width. In *H. craspedotum*, moreover, the cusps are much more robust and less elevated. The following measurements indicate the range in size of the individual:

	MM.	MM.	MM.	MM.	MM.	MM.
						TYPE.
Length of premolars 3 and 4 and lower molars	36	32	......	......	38	31
Length of last lower molar	09	10.5	12	10	09.5	09
" molars 1 and 2	14.5	14	17.5	15	16.5	11.5
" premolars 3 and 4	12	12	......	......	12	10

All of the foregoing species of *Hyracotherium* are readily distinguished from the European species *H. duvali* and *H. leporinum*, by the greater simplicity of sup. pm. 2, which in these latter species has but a single external cusp. In all the American species this tooth has two external cusps. It may yet be found that there are other important differences between these groups which will necessitate recognizing a separate genus for the American forms, in which event the name *Eohippus*, proposed by Marsh, would have to be adopted.

Subgenus **Pliolophus** *Owen.*

As already remarked, this is a genus of very doubtful validity. A number of specimens occur in our collections in which the fourth lower premolar has a more or less distinct fourth cusp. In no instance in which I have observed it, however, can this tooth be said to be fully molariform, almost all degrees of distinctness being met with. With few exceptions these specimens agree in every respect with *H. index*, and whether they are to be regarded as of generic importance, or are best treated as specific variations, is a question difficult to determine. From the very great similarity between these specimens and those of *H. index*, as well as the great variability in the size of the cusp in question, one is almost tempted to believe that they are only individual variations of this species. I will consider them here under the subgeneric title *Pliolophus.*

Hyracotherium (Pliolophus) cristonense[1] *Cope.*

The type of this species consists of an almost entire mandible lacking only the posterior portion (No. 1002, Nat. Mus. Coll.); it

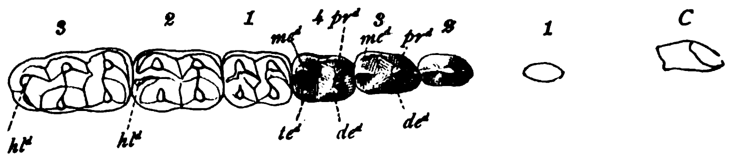

Fig. 11.

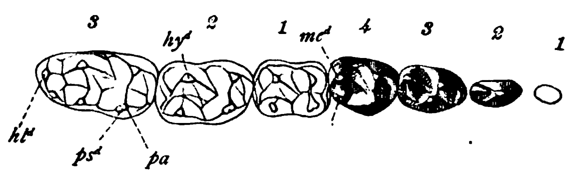

Fig. 12.

Figs. 11 and 12. *Hyracotherium* (*Pliolophus*) *cristonense.*

Fig. 11. Lower teeth, crown view (type specimen, No. 1002 Nat. Mus. Coll.). Wahsatch Beds, New Mexico. X $\frac{3}{2}$.

Fig. 12. Lower teeth, crown view (No. 165). Wahsatch Beds, Big Horn. X $\frac{3}{2}$.

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[1] Wheeler Surv. Reports, IV, p. 254; Tert. Vert., p. 651.

is from the Wahsatch of New Mexico. It is about the size of the larger specimens of *H. index.* The first lower premolar is single rooted, and separated by a considerable diastema from the second. The third premolar has a very small second anterior cusp, and the fourth cusp on the last or fourth premolar is rather distinct. (Nos. 157*a*, 165, 4582 and 4603 of the Am. Museum collections.) One specimen in the collection (No. 165) shows a very decided variation, upon which I hesitate to propose a new species. The diastema between the first and second lower premolars is practically absent, and there is a well-developed second anterior cusp upon the third lower premolar. The first premolar is one-rooted, and the fourth has a very small fourth cusp. Several other species have been referred here by Cope, notably *P. loevi* and *P. cinctus.* The former of these I regard as a small variety of *cristonense*, and the latter I consider to belong to *Orohippus*, since it is from the Bridger formation.

Hyracotherium (Pliolophus) montanum, sp. nov.

I propose this species upon two fragments of lower jaws (No. 4593) of the same individual. The distinguishing character of this species is (1) the absence of any diastema between the first and second premolars, and (2) the two-rooted condition of the

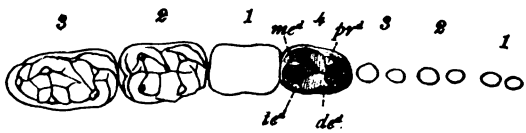

Fig. 13. *Hyracotherium (Pliolophus) montanum.* Lower teeth, crown view (type specimen, No. 4593). Wahsatch Beds, Big Horn. X ½.

first premolar. In the specimen here described the crowns of the three anterior premolars are not preserved, but the roots indicate the characters mentioned above. The fourth premolar displays a small but distinct fourth cusp. The last two molars which are preserved exhibit the same structure as those in *H. index*, with the larger of which the present specimen agrees in size.

Protorohippus, gen. nov.

I come lastly to consider the Wind River representative of the horse family, which led directly up to the later Bridger form *Orohippus* (*Pachynolophus*). The *generic characters* have already been referred to above, but may now be more definitely stated as follows: No vestige of the fifth digit in the hind foot. Superior molars with subcrescentic external cusps, and having frequently small but distinct rudiments of mesostyle and hypostyle. Fourth superior premolar with only three principal cusps, the fourth (antero-internal in this case) small and more or less in the position of an intermediate. Third superior premolar with four principal cusps, the antero-internal considerably enlarged and shifted inwards to form a cusp analogous with the protocone of the true molars.

By giving to this form a separate generic name we have a distinct genus for each of the groups of species in the four great divisions of the Eocene, as represented in this country, viz.: *Hyracotherium* in the Wahsatch, *Protorohippus* in the Wind River, *Orohippus* in the Bridger, and *Epihippus* in the Uinta.

Of these, *Hyracotherium* is the oldest and clearly the most primitive; this is seen in the vestige of the fifth digit in the hind foot, the low conic form of the outer cusps of the superior molars, without any trace of the mesostyle or hypostyle, as well as the simple premolars. This is followed by *Protorohippus*, which has made a distinct advance in the loss of the vestige of the fifth digit in the hind foot, as well as the advance in the structure of both molars and premolars. *Orohippus* (*Pachynolophus*) continues the phylum into the Bridger, where the *third* and *fourth* premolars become fully molariform. This is again closely followed by *Epihippus* of the Uinta, in which the *second* superior premolar has assumed the molariform pattern, while from this latter genus to *Mesohippus* of the White River Miocene is but a short step, the only difference between the two which I am able to distinguish with certainty being the more perfectly molariform structure of the second superior premolar, and the reduction of the fifth digit of the *fore foot* to a vestige in the White River genus.

Protorohippus venticolus (*Cope*).

The type of this species is the more or less perfect skeleton described by Cope as *Hyracotherium venticolum* (No. 4832). The specific characters have been so fully stated by this author that I am unable to add anything to his original description. The

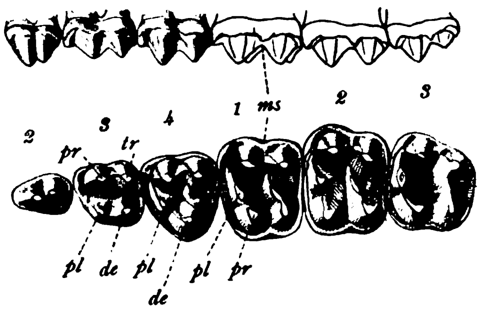

Fig. 14.

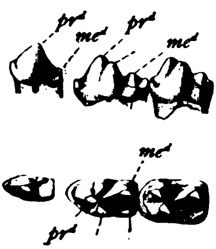

Fig. 15.

Figs. 14 and 15. *Protorohippus venticolus.*

Fig. 14. Upper teeth, side and crown views (composition from Nos. 4839 and 4832). Wind River Beds. X $\frac{4}{3}$.

Fig. 15. Lower premolars, side and crown views (No. 4834). Wind River Beds. X $\frac{4}{3}$.

teeth of the type specimen are badly worn, and without additional material it would have been impossible to make out those important characters of the teeth, which in my judgment take it out of the genus *Hyracotherium.* A number of smaller specimens from the Wind River Beds (Nos. 4833–41) display the same characters as the type of the genus, but I hesitate to group them into a distinct species until more is known of them.

Principles of Premolar Evolution in the American Horses.

A scheme of nomenclature for the cusps of the premolars has been proposed by Prof. W. B. Scott[1] for all the mammalia, in which it is attempted to express the homologies of the several parts of the tooth crown in all forms. Owing to some differences in the order of appearance of the several cusps in the different

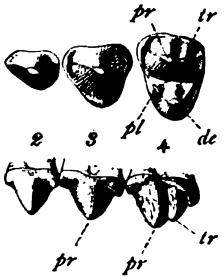

Fig. 16. *Euprotogonia puercensis.* Upper premolars, crown and side views (No. 3874). Puerco Beds of New Mexico. X 4/3.

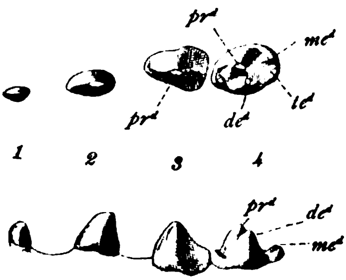

Fig. 17. *Euprotogonia plicifera.* Lower premolars, crown and side views (No. 4084). Puerco Beds of New Mexico. X 4/3.

premolars, he selects the fourth as being constant in the manner in which the successive parts have been added. He says,[2] "so far as I have been able to observe, the scheme of development of the premolar crown is quite constant, and for superior premolar 4 universally so, and the nomenclature which is here

[1] Proc. Acad. Nat. Sci. Phila., 1892, p. 405.
[2] Loc. cit., p. 414.

proposed for the premolar cusps is intended to express their order of succession as they appear in this tooth."

The crown of the premolar in either jaw in its most primitive stage, consists of a single cone implanted by a single root; to this is added a second cusp, sometimes, as in the *superior series* of *Euprotogonia*, to the *inner* or lingual side of the primitive cone, and sometimes, as in *Hyracotherium index* and *Systemodon primævus*, immediately *posterior* to the primitive cone. The third element always makes its appearance either as this posterior cusp just mentioned (*Euprotogonia*), or as the internal cusp (*Hyracotherium*). In this stage of development we have therefore a three-cusped tooth with a triangular crown.

The primitive cone always occupies the same position, viz.: at the antero-external angle of the crown, and is known as the *protocone*. The cusp which is added to the lingual side of this cusp, irrespective of whether it appears previous to or subsequent to the posterior cusp, is given by Scott the name of *deuterocone*. In like manner the third cusp is called the *tritocone*.

In regard to the further complication of the tooth crown by which the tooth passes from a tritubercular to a quadritubercular stage, Prof. Scott further says: "The final step in the conversion of the premolar to the molar pattern is given by the addition of a fourth main element at the postero-internal angle of the crown, the *tetartocone*, which corresponds in position to the hypocone of the molars." Examples of this addition are to be seen in many forms, and it has undoubtedly been the usual method in the evolution of these teeth.

In the horse series of America, however, the addition of this fourth main element to the crowns of the superior premolars has pursued an entirely different course, and instead of appearing at the postero-internal angle of the crown, *it has been added at the antero-internal angle*. The proof of this assertion is to be found in the third and fourth superior premolars of *Hyracotherium index* and *Protorohippus venticolus*.

In the former of these species the crown of the fourth premolar is made up of two strong subequal more or less conic external cusps, together with a large simple median more or less lunate internal cusp. A little anterior and internal to this cusp, as if it were a slightly constricted off part of the large crescentic internal, is a small cusp, occupying the position of an intermediate or protoconule. In the third premolar this same cusp is to be seen, but it is stronger and has a more forward position, giving to the crown a more quadrangular outline.

In *Protorohippus venticolus* this cusp in the crown of the third premolar is decidedly stronger, and has such a forward and internal or lingual position as to give to the crown quite a quadritubercular appearance. In the fourth premolar the position of this cusp is more nearly as it is in the third premolar of *H. index*, and the crown has not made as rapid progress towards the quadritubercular condition as the third. It has, however, made considerable advance in the direction of the formation of the antero-internal cusp, as is seen in the more forward and inward position of the element which is destined to become the fourth tubercle.

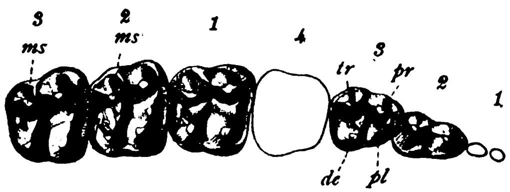

Fig. 18. *Orohippus.* sp. Upper teeth, crown view (composition from Nos. 1735, 1737 and 1738). Bridger Beds, Wyoming. X 1/1.

In the Bridger species of *Orohippus* a still further advance is made, and both third and fourth premolars have become almost fully molariform or quadritubercular by the still greater enlargement and growing inwards of this cusp under consideration.

It is thus demonstrated, I hold, that the antero-internal cusp in these premolars was the last of the principal elements added, and while it is analogous, so far as the date of its appearance is concerned, with the *tetartocone* in other forms, it is not homologous with the cusp so named, either in position or in origin.

Another fact of much interest in this connection is the practical assumption of the molariform structure of the third superior premolar in advance of the fourth in the American Horses. This is apparently not true of the European species, if one can place any dependence upon the drawings of Kowalewsky and Rütimeyer, nor, on the other hand, is it true that the antero-internal cusp was the last one to be added to complete the quadritubercular crown in the European species, as I have attempted to show above is true of the American species. Upon this ground I hold that the Lower Eocene European and American Horses probably represent entirely distinct phyla, having in all probability a common beginning in the least modified species of the genus *Hyracotherium.*

EXPLANATION OF PLATE II.

Upper and Lower Teeth of Eocene Horses.

A—E. Upper teeth. All natural size.

A. *Euprotogonia puercensis*, No. 3874, Puerco Beds, New Mexico.

B. *Hyracotherium tapirinum*, Nos. 139, 212, Wahsatch Beds, Big Horn.

C. " *index*, No. 4602, Wahsatch Beds, Big Horn.

D. *Protorohippus venticolus*, Nos. 4839, 4832, Wind River Beds.

E. *Orohippus* sp., Nos. 1735, 1737 and 1738, Bridger Beds.

F—N. Lower teeth. All natural size.

F. *Euprotogonia plicifera*, No. 4084, Puerco Beds, New Mexico.

G. *Hyracotherium vasacciense*, No. 4659, Wahsatch Beds, Big Horn.

H. " *cristatum*, Nos. 240, 258*b*, " " "

I. " (*Pliolophus*) *cristonense*, No. 165, Wahsatch Beds, Big Horn.

I'. " " " (No. 1002, Nat. Mus. Coll.), Wahsatch Beds, New Mexico.

J. " " *montanum*, No. 4593, Wahsatch Beds, Big Horn.

K. " *tapirinum*, Nos. 143*a*, 4657, Wahsatch Beds, Big Horn.

L. " *index*, No. 4613, Wahsatch Beds, Big Horn.

M. " *craspedotum*, No. 4830, Wind River Beds.

N. *Protorohippus venticolus*, No. 4834, " " "

Abbreviations: *pr.* = protocone, *me.* = metacone, *pa.* = paracone, *de.* = deuterocone, *tr.* = tritocone, *hy.* = hypocone, *pl.* = protoconule, *ms.* = metastyle, *prd.* = protoconid, *pad.* = paraconid, *med.* = metaconid, *hyd.* = hypoconid, *ded.* = deuteroconid, *ted.* = tetartoconid, *psd* = parastylid, *hld.* = hypoconulid.

Article VII.—CRITICAL REVIEW OF THE SESIIDÆ FOUND IN AMERICA, NORTH OF MEXICO.

By William Beutenmüller.

The Clear-winged Moths or Sesiidæ (Ægeriidæ) may be superficially recognized by their narrow and more or less transparent wings, by the filiform or clavate antennæ being either ciliate, pectinate or simple ; also by the tuft at the end of the body which they can spread like a fan, especially in the male. They fly rather swiftly in the hottest sunshine, and may be readily mistaken for wasps and flies, which they resemble in appearance. On the whole the specific and generic differences of the Sesiidæ are very slight, though constant in most cases, but it requires considerable attention and careful comparison of specimens to distinguish one from another. In some species the males differ from the females, and in many instances the male has been described under one name and the female of the same species under another, or individuals more or less worn through age and flight have been described and named as different species, thus creating considerable confusion in the study of this group of Moths and in our lists. It has, therefore, seemed to me advisable for the present to consider the species only, leaving the generic value of some of the groups here recognized as genera for future consideration, and until more material has been obtained.

My studies of the Sesiidæ have been mainly based upon the types and material in the Hy. Edwards Collection in the American Museum of Natural History.

I am also under obligation to many friends and correspondents for generous aid, otherwise this paper could not have been prepared.

To Mr. G. F. Hampson, of the British Museum, I am indebted for notes and colored sketches of Walker's types.

I am also indebted to Mr. L. O. Howard for the loan of types and specimens from the U. S. National Museum Collection, and

to Prof. W. B. Barrows (through Mr. G. C. Davis) for loan of types in the Tepper Collection in the Agricultural College of Michigan.

To Mr. S. Henshaw for material from the Museum of Comparative Zoölogy at Cambridge, Mass., and for notes on Harris's types in the Boston Society of Natural History; to Prof. J. H. Comstock for loan of material from the Cornell University Collection at Ithaca, N. Y.; to Mr. J. Doll for allowing me to examine the types in the Neumoegen Collection.

For notes and specimens I am also under obligation to the following entomologists: Prof. Otto Lugger, St. Anthony Park, Minn.; Prof. D. S. Kellicott, Columbus, Ohio; Prof. F. H. Hillman, Reno, Nevada; Dr. H. H. Behr, San Francisco, Cal.; Prof. A. D. Hopkins, Blackburg, W. Va.; Messrs. Chas. Palm, L. H. Joutel, H. G. Dyar, and Mrs. A. T. Slosson, New York; J. L. Zabriskie, Brooklyn; Prof. A. R. Grote, Bremen, Germany; F. W. Kirby of the British Museum, and for many favors to Mr. Wm. Schaus.

With the aid of the types and material which have been submitted to me for examination I have been enabled to recognize all the known species of Sesiidæ found in America, north of Mexico, except the following: *Albuna modesta* Kellicott and *Melittia snowii*, which I have not had the opportunity to examine. The following species, described by Boisduval, are also unknown to me, viz.: *Sesia anthraciformis*, *S. bibionipennis*, *S. nomadæpennis*, *S. chrysidipennis* and *S. xiphiæformis*. Prof. A. R. Grote and myself are of the opinion that the latter species is the same as the female of *Sanninoidea exitiosa*.

In previous papers I have used the term Ægeriidæ instead of Sesiidæ. This latter term has precedence, and must be used. The type of the genus *Sesia* is, so far as we can ascertain, *culiciformis*, it having been restricted to this species by Hübner (Tentamen, 1806).

As stated in the Museum Bulletin, Vol. VI, p. 87, a monograph of the Sesiidæ inhabiting North America is in course of preparation, and material from all parts of the world would be greatly appreciated; also local lists, notes on the life histories, habits, etc., of the American species, even of the most common, would be gratefully received.

As the specimens of this family soon become abraded through flight and discolored through age, perfect examples are required for description and figuring, especially as to their coloration, and specimens sent to me for this purpose would be safely returned if desired.

Melittia curcurbitæ (*Harris*).

Ægeria curcurbitæ HARRIS, New England Farmer, Vol. VIII, 1828, p. 33.
Trochilium ceto WESTWOOD, Orient. Cab. Ent. 1848, pl. 30, fig. 6.

This well-known species was described by Harris as *Ægeria curcurbitæ*, and later by Westwood as *Trochilium ceto*; consequently the former name must be used. Doubleday (Harris's Corresp., 1869, p. 161) states that *Ægeria curcurbitæ* is *Melittia satyriniformis* Hübner, and if so this latter name would have precedence. Mr. Samuel Henshaw kindly examined for me Hübner's work (Zuträge Exot. Schmett., 1825), in the library of Harvard University, and writes me as follows: "The figure of *Melittia satyriniformis* differs from all *curcurbitæ* that I have seen, in coloration ; the abdomen is dark blue black with light blue margins to each segment and without a trace of the orange so conspicuous in *curcurbitæ*."

Habitat: Canada, United States, Central and South America.

The larva lives in the stems of the cucumber and other allied plants.

Melittia amœna *Hy. Edw.*

Melittia amœna HY. EDWARDS, Papilio, Vol. II, 1882, p. 53.

Not known to me. It was described from a single male, and the type is said to be in the collection of Prof. Snow. Hy. Edwards describes it as follows:

"Head black in front, with a few bluish scales. Palpi above orange, beneath white, terminal joint black within. Eyes dull orange, with the orbits clear white. Antennæ bluish black. Thorax dull bronze black, with the collar pale dull greenish, and the long hairs on the sides sordid white, with dull greenish reflection. Abdomen black, with purplish reflection ; posterior edges of the segments narrowly greenish white. Caudal tuft orange brown, with black hairs. Bands on the lower side of abdomen a little wider than above. Fore coxæ black, with orange scales. Middle and hind coxæ black, edged with whitish. Fore and middle tibiæ rich orange exteriorly ; black within. Bunch of hairs on hind tibiæ rich orange, with a few white hairs intermixed; black within. All the tarsi are black. Fore wings purplish black, covered with bright metallic green scales, less visible below. Fringes of both wings brownish black. Expanse, 27 mm. *Habitat:* Kansas."

Melittia snowii *Hy. Edw.*

Melittia snowii HY. EDWARDS, Papilio, Vol. II, 1882, p. 53.

Allied to *M. curcurbitæ*. The fore wings are pale grayish brown, without any metallic green lustre. The hind tibiæ are also pale grayish brown, and the tarsi clothed with black hairs within. Palpi white. Expanse, 22 mm.

Habitat: Kansas.

Melittia gloriosa *Hy. Edw.*

Melittia gloriosa HY. EDWARDS, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 71.

This beautiful species may be known by its large size and robust form.

The fore wings are light grayish brown with a slight orange tint. The hind wings in the male are transparent, with the veins and inner margin heavily marked with bright orange; hind wings of the female entirely covered with orange scales. Thorax grayish brown. The abdomen has the top of the first, second and fourth segments grayish brown; third and fifth segments yellow; sides orange; last two segments grayish brown, with a decided metallic light blue reflection; the extreme posterior edge of each segment is scaled with light blue; hind tibiæ and tarsi with long orange hairs; black outside and straw yellow at base of tibiæ. The antennæ of the male are strongly bipectinate. Expanse, 41 mm.

Habitat: California.

The insect was reared by F. E. Blasedale from the roots of *Rhus laurina* (Proc. Ent. Soc. Wash., Vol. I, p. 85). Dr. H. H. Behr writes me that the larva feeds in the herbaceous climbing stems of *Megarrhiza*.

Melittia grandis (*Strecker*).

Trochilium grandis STRECKER, Can. Ent. Vol. XIII, 1881, p. 156.

Closely allied to *M. gloriosa*, but it is quite distinct. The fore wings are similar in color to *gloriosa*. The hind wings in both sexes are transparent. The abdomen is brown dorsally and orange laterally, with the posterior edges of each segment very narrowly scaled with pale grayish brown. The underside of the abdomen is pale orange, while in *gloriosa* it is whitish. The pectinations of the antennæ of the male are also not as long as in *gloriosa*. Expanse, ♂, 38; ♀, 45 mm.

Habitat: Arizona and Texas.

Gaëa (gen. nov.) **solituda** (*Hy. Edw.*).

Larunda solituda HY. EDWARDS, Papilio, Vol. I, 1881, p. 182.

The wings of this insect are dirty brown, streaked with dull orange and yellow in the cell of the fore wings and in the area beyond the discal mark. The hind wings are transparent at the extreme base, and marked beyond with dull orange between the veins. The abdomen has a yellow band on each segment. The antennæ of the male are rather strongly pectinated, simple in the female. Expanse, 31 mm.

Habitat: Kansas and Texas.

The name *Larunda*, given by Hy. Edwards to this species, was previously established by Hübner (Verzeich. bek. Schmett., 1816, p. 289) for a genus in the Geometridæ, and therefore must be changed. I propose the name *Gaëa* instead, with *L. solituda* Hy. Edw. as the type.

Gaëa emphytiformis (*Walker*).

Ægeria emphytiformis WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 43.
Bembecia emphytiformis GROTE, Check List N. Am. Moths, 1882, p. 11; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 23.

A type female of Walker's *Ægeria* (*Bembecia*) *emphytiformis* from the British Museum is before me. It is not a *Bembecia*, but is congeneric with *Gaëa solituda*, to which it is allied, but is much smaller. The fore wings are purplish brown with slight traces of a few reddish streaks in the area beyond the discal mark. Hind wing also purplish brown, transparent at the base, orange at base of inner margin. In *solituda* the spaces between the veins are heavily marked with dull orange yellow. Expanse, 20 mm.

Habitat: United States (Walker). The definite locality is not known.

Euhagena nebraskæ *Hy. Edw.*

Euhagena nebraskæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 180.
Pyrrhotænia coloradensis BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 25.

A very remarkable form, differing greatly from any other species known to me. I have examined the type in the Cambridge Museum, and find that the insect I described as *Pyrrhotænia coloradensis* to be the same. Mr. L. O. Howard kindly sent me for study a perfect male from the collection of the U. S. National Museum.

The antennæ are thick with rather long, closely applied pectinations which extend to a little before the tip. The palpi are erect and clothed with loose, long hairs, as are also the head and collar. The wings are opaque, red, with a rather broad discal bar. The margins of the wings are black with the fringes fuscous. Over the outer portion, the hind wings are thinly scaled with black. Thorax black with some silvery white hairs. The hairs on the head, collar and palpi are also mixed with white. Abdomen black with a silvery white scale-like band on each segment; femora and tibiæ with short loose hairs. Anal tuft black. Expanse, 18–22 mm.

Habitat: Colorado and Nebraska.

Alcathoë caudatum (*Harr.*).

Ægeria caudata HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1838, p. 311; WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 42; PACKARD, Guide Study Insects, 1869, p. 278; MARTIN, 5th Rep. Nox. Ins. Illinois, 1881, p. 108.
Trochilium caudatum FITCH, Nox. Ins. N. Y. 1856, p. 424; MORRIS, Synop. Lepid. N. Am. 1862, p. 139; BETHUNE, Can. Ent. Vol. I, p. 18; HY. EDWARDS, Papilio, Vol. II, 1882, p. 53.
Sesia caudata BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 437.
Alcathoë caudatum HY. EDWARDS, Papilio, Vol. II, 1882, p. 53; SMITH, Ent. Am. Vol. IV, 1888, p. 11; Cat. Ins. N. J. 1890, p. 288; BEUTENMÜLLER, Cat. Lepid. N. Y. 1890, p. 204; KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 44.
Alcathoë caudata JACK, Garden and Forest, 1891, p. 496. (Larva and pupa.)

Male.—Fore wings transparent from the base to the middle, with the costal and inner margins and outer half purplish brown with a purplish reflection; hind wings transparent, bordered with purplish black; legs orange, hind tibiæ clothed with black hairs; abdomen with a long orange anal tail-like appendage, and a short black pencil on each side at the base; antennæ orange.

Female.—Fore wings entirely purplish brown; legs black, tarsi orange. Abdomen in both sexes black. Expanse, 20–32 mm.

Habitat: Canada, Michigan, Illinois, New York, south to Virginia.

The legs of the insect are subject to variation, being marked more or less with black. The form with entirely black legs and antennæ has been named *walkeri* by Mr. Neumoegen.

Harris states that the larva inhabits the stems of our indigenous currant (*Ribes floridum*). Mr. Jack in 'Garden and Forest,' 1891, p. 496, gives a good account and figure of the larva and habits. He states that it bores in the roots of *Clematis*. Mr. Joutel and myself have also raised the species from this plant. Harris's observation is certainly founded upon an error. Mr. J. Doll has also raised the insect from the roots of *Clematis*.

Sannina uroceriformis *Walker*.

Sannina uroceriformis WALKER, Cat. Lep. Brit. Mus. pt. VIII, 1856, p. 64; MORRIS, Synop. Lepid. N. Am. 1862, p. 334 (quotes Walker); BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.
Saunina uroceripennis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 465; HY. EDWARDS, Ent. Amer. Vol. III, 1888.
Ægeria ? quinquecaudata RIDINGS, Proc. Ent. Soc. Phil. Vol. I, 1862, p. 277; PACKARD, Guide to Study of Insects, 1869, p. 279.
Sospita quinquecaudata HY. EDWARDS, Papilio, Vol. II, 1882, p. 56.
Phemonoë quinquecaudata HY. EDWARDS, Papilio, Vol. II, 1882, p. 97; RILEY, Proc. Ent. Soc. Wash. Vol. I, 1888, p. 85; Insect Life, Vol. IV, 1892, p. 332.

A colored figure of the type of this species in the British Museum was kindly sent to me by Mr. G. F. Hampson, and it is without doubt the female of *Phemonoë quinquecaudata* Ridings. The example regarded by Walker as the female is probably the female of *S. exitiosa*. Boisduval changed the name to *Saunina uroceripennis* in order to avoid confusion with the Europeon *Sesia uroceriformis*. The change, however, was superfluous, as our species is generically distinct from the European.

The insect is wholly blue black, with an orange band on the fourth segment above; sometimes in the male the fourth, fifth and sixth segments are orange yellow above. The hind wings are transparent at the extreme base. The male has five tufts at the end of the body. Expanse, 30–33 mm.

Habitat: Virginia to Florida; Montana.

The larva lives in the roots of Persimmon.

Trochilium pacificum *Hy. Edw.*

Trochilium pacificum Hy. Edwards, Påpilio, Vol. I, 1881, p. 180.
Trochilium californicum Neumoegen, Ent. News, Vol. II, 1891, p. 108.

In the Museum Bulletin, Vol. VI, p. 365, I proposed to unite *Trochilium californicum* with *T. pacificum.* Since then I have examined the type of *californicum* in the Neumoegen Collection, and find that my conclusion was correct. The larva bores in the Cottonwood.

Habitat: Nevada, Montana, California and Washington.

Trochilium tibiale *Harris.*

Trochilium tibiale Harris, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 309.
Trochilium minimum Neumoegen, Ent. News, Vol. II, 1891, p. 108.

The type of *T. minimum* Neum. was examined by me, and it is the same as *T. tibiale.* This verifies my conclusion of uniting the two species as mentioned in the Museum Bulletin, Vol. VI, p. 366. The larva inhabits the Poplar and Willow.

Habitat: New York, Canada, New Hampshire, Massachusetts, Colorado, California and Vancouver Island.

Trochilium apiforme (*Linn.*).

This well-known European species is found in this country as far west as Nevada. It inhabits the roots and lower parts of the trunks of Poplar and Willow. The insect is said to be very sluggish in habit, and to be readily picked off the trees when resting.

Bembecia marginata (*Harris*).

The type of *Bembecia pleciæformis* Walker in the British Museum was kindly examined for me by Mr. G. F. Hampson, and his note is as follows: "The type of *Bembecia pleciæformis* is a male in bad condition, but without the least doubt it is the same as *B. marginata.* The markings are exact, as are the metallic blue pectinated antennæ; the partial obsolescence of the yellow bands on the thorax and abdomen is due to grease, but they are traceable." The synonymy[1] of the species now stands as follows:

BEMBECIA MARGINATA *Harris.*
" *pleciæformis* WALKER.
" *odyneripennis* WALKER.
" *rubi* RILEY.
" *flavipes* HULST.

Habitat: Canada, westward to Gulf of Georgia; Atlantic States, Ohio and Missouri.

The insect in its larval state lives in the roots and canes of Blackberry and Raspberry. The female moth is sluggish in habit, and drops to the ground when touched. The male, however, is very active. The variety *albicoma* has white bands on the abdomen instead of yellow, as in the type form.

Vespamima sequoiæ (*Hy. Edw.*).

Bembecia sequoiæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 181.
Vespamima sequoiæ BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 87.

This species was described as a *Bembecia*, but was placed in a new genus (*Vespamima*) by me. It is distinct from *Bembecia*, differing by having much longer antennæ, which are ciliate in the male instead of with long pectinations as in *Bembecia*. It also differs in shape and venation. The larva is destructive to *Sequoia sempervirens*, *Pinus ponderosa* and *Pinus lambertiana* in California. *Bembecia superba* was placed by me as a synonym of *V. sequoiæ* (Bull. A. M. N. H., Vol. VI, p. 87).

Sciapteron denotata (*Hy. Edw.*).

Albuna denotata HY. EDWARDS, Papilio, Vol. II, 1882, p. 55.
Sciapteron denotata BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.

Originally described as an *Albuna*, but placed by me in the genus *Sciapteron*. It is closely related to the European *S. tabaniformis*, but is a much smaller insect, and differs in the number of bands on the abdomen in the female.

[1] See Bull. Am. Mus. Nat. Hist., Vol. V, 1893, p. 22.

Fore wings sooty black with a strong violet reflection ; along the inner margin lined with rufous ; at the insertion of the fore wings is a yellow spot. Collar yellow ; palpi black, tips yellow. Abdomen black with a yellow ring on the second, fourth and last two segments in the male. In the female there are five bands on the abdomen. Antennæ violet black above, rufous beneath, bipectinate in the male, simple in the female. Coxa yellow, femora black, middle femora with an orange band ; hind femora orange, black at base ; all the tarsi orange. Expanse, 27 mm.

Habitat: New Hampshire, westward to Montana.

Sciapteron tricincta (*Harr.*).

Ægeria tricincta HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 310.
Sciapteron tricincta HY. EDWARDS, Grote, New Check List of Moths, 1882, p. 12.

Closely allied to *denotata*, but differs by having three broad bands on the abdomen in the male and four in the female. The species was reared by Prof. D. S. Kellicott from enlargements of the branches and stems of Poplar (*Populus candicans*) and Willow (*Salix*), caused by the larva of *Saperda concolor* and *S. moësta.*

Habitat: Canada, Massachusetts, New York, Ohio, Pennsylvania and Michigan.

Sciapteron robiniæ *Hy. Edw.*

Sciapteron robiniæ HY. EDWARDS, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 72.

This insect was described as having the thorax brown on the disc, yellow in front and behind. The types, which are before me, have the scales on the thorax abraded. A fresh example from the collection of the Museum of Comparative Zoölogy may be described as follows :

The thorax is deep black, with the patagia tipped with yellow at the posterior edge, and a transverse curved streak across the hind part of the thorax. Collar black, edged with yellow behind. Fore wings orange brown, veins somewhat darker. Hind wings transparent. Abdomen with first three segments above and below deep black, and not blackish brown, as in the original description. The second segment with a narrow yellow band, and the third segment with only a very slight trace of a band at the posterior edge ; remaining segments wholly yellow. Expanse, 25–35 mm.

Habitat: Nevada, California and Washington.

According to the late Hy. Edwards this species is destructive to *Robinia pseudacacia* and *Populus alba.*

Sciapteron cupressi *Hy. Edw.*

Sciapteron cupressi HY. EDWARDS, Papilio, Vol. I, 1881, p. 183.

Only known by a single type in the Neumoegen Collection, which I have examined. It is a female, and not a male as described by Mr. Edwards. It differs from *S. robiniæ*, to which it is closely allied, if not identical, by having only the first segment black and the second and third segments marked with orange, while the remaining segments are wholly yellow. Expanse, 30 mm.

Habitat: Colorado.

Sciapteron scepsiformis *Hy. Edw.*

Sciapteron scepsiformis HY. EDWARDS, Papilio, Vol. I, 1881, p. 183.

Fore wings deep blackish brown; hind wings transparent, with the outer border running some distance inward between the veins. The abdomen is brown with a narrow yellow ring at the end of the second segment. Expanse, 26 mm.

Habitat: Maryland, Kansas and Texas.

The male and food habits are unknown.

Sciapteron simulans *Grote.*

Trochilium (Sciapteron) simulans GROTE, Bull. U. S. Geol. Surv. Hayden, Vol. VI, 1881, p. 257; Bull. Brooklyn Ent. Soc. Vol. III, 1881, p. 78.
Trochilium luggeri HY. EDWARDS, Psyche, Vol. VI, 1891, p. 108, pl. fig. 3; Bull. 43, Minnesota Agricul. Exp. St. p. 190, fig.
Sciapteron simulans BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

The type of *Trochilium luggeri* was kindly presented to me by Prof. Otto Lugger, and it is without doubt the same as *Sciapteron simulans* Grote, the type of which is also before me. Only the female is known. Prof. Lugger has bred the insect from Red-oak stumps.

Habitat: Rhode Island, Ohio, Illinois and Minnesota.

Sciapteron palmii (*Hy. Edw.*).

Fatua palmii Hy. Edwards, Can. Ent. Vol. XIX, 1887, p. 145.
Sciapteron palmii Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

This species is closely allied and congeneric with *S. simulans.* Only the female is known, and it is possible that a new genus will have to be erected for *palmii* and *simulans* when the males are known. The food habits are unknown.

Habitat: Florida.

Sciapteron dollii *Neumoegen.*

Sciapteron dollii Neumoegen, Ent. News, Vol. V, 1894, p. 330.

The late Hy. Edwards gave to this insect the name *Sciapteron castaneum*, the type of which is in the Neumoegen Collection. I am, however, unable to find a published description of this species anywhere in Mr. Edwards's papers, and conclude that it must be a MS. name. Two examples in the Edwards Collection are labeled *Trochilium polistiformis* Harris, and Mr. Edwards's note-book says "*Sciapteron castaneum=polistiformis.*" It therefore seems to me quite evident that before publishing *castaneum* he considered it the same as *polistiformis*, which is a different species. The larva lives in the trunk of young Poplar.

Habitat: New York, Kentucky and Texas.

Sciapteron polistiformis (*Harris*).

Ægeria polistiformis Harris, Am. Pomol. Soc. 1854, p. 10; Packard, Guide Study Insects, 1869, p. 278; Riley, 3d Rep. Nox. Ins. Mo. 1871, p. 75; Martin, 5th Rep. Nox. Ins. Ill. 1881, p. 108; Saunders, Ins. Inj. Fruit, 1883, p. 229.
Trochilium polistiformis Fitch, 3d Rep. Nox. Ins. N. Y. 1856, p. 387.
Sciapteron seminole Neumoegen, Ent. News, Vol. V, 1894, p. 330.

The types of Harris's *Ægeria polistiformis* are in the collection of the Boston Society of Natural History, and were kindly examined for me by Mr. Henshaw, who informs me that they agree very well with Riley's figures of the species (Third Rep. Nox. Ins.

Mo., p. 75). I have examined the type of *Sciapteron seminole* and find that this also agrees very well with Riley's figure and description of the female of *polistiformis*. I therefore propose to unite it with the latter species. The insect in its larval state burrows in the bark and sap-wood of the roots of both wild and cultivated Grape-vine.

Habitat: North Carolina, Florida, Missouri and Arizona.

Palmia (gen. nov.) **præcedens** (*Hy. Edw.*).

Sciapteron præcedens HY. EDWARDS, Papilio, Vol. III, 1883, p. 155.

Only known by a single specimen in the Neumoegen Collection. It is not a *Sciapteron*, but the type of a new genus. It differs from *Sciapteron* by having narrower wings with the apices very pointed and the outer margins more oblique. The palpi are much shorter, and not clothed with long hair-like scales as in *Sciapteron*. In *Sciapteron* the apices of the wings are rounded and the palpi more erect, reaching the vertex of the head, and are thickly clothed with long hair-like scales. The venation of *S. præcedens* is the same as in *Sciapteron*. The wings are brown, with a basal vitreous streak on the fore wings. The hind wings are vitreous at their base. Abdomen black, with the last three segments and anal tuft lemon yellow. The head is also smaller. Expanse, 30 mm.

Habitat: North Carolina.

I propose the name *Palmia* for this genus, with *S. præcedens* H. Edw. as type.

Tirista admiranda (*Hy. Edw.*).

Sciapteron admirandus HY. EDWARDS, Papilio, Vol. II, 1882, p. 54.
Tirista admirandus BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 88.

This species has been placed by me in the genus *Tirista*. A figure of *Tirista argentifrons* was published by Mr. Druce in Biologia Centrali-Americana, Vol. I, Heterocera, Plate V, Figure 14, with which *admirandus* fairly well agrees generically. It differs from

Sciapteron by having plumose antennæ. Only a single specimen of this insect is known at present.

Habitat: Texas.

Tarsa denudata (*Harr.*).

Trochilium denudatum HARRIS, Am. Journ. Sc. and Arts, Vol. XXXVI, 1839, p. 310.
Fatua denudata HY. EDWARDS, Papilio, Vol. II, 1882, p. 97.
Tarsa bombyciformis WALKER, Cat. Lep. Br. Mus. pt. VIII, 1856, p. 61.
Sesia asilipennis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. Vol. I, 1874, p. 91.
Tarsa denudata BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 22.

Easily recognized by its large size. The male has the fore wings transparent, bordered with brown and an oblique brown cross-bar, centred with rufous, at the end of the cell. Abdomen with a narrow yellow band at the posterior end of each segment. The antennæ have very long pectinations. The female has the fore wings opaque, brown, a triangular transparent mark at the hind angle, and the antennæ simple. Expanse, 32–43 mm.

Habitat: New York, Massachusetts, New Jersey, District of Columbia, South Carolina, Georgia, Illinois, Michigan and Texas.

The larva lives in the roots and under the bark of Ash and Alder.

Parharmonia pini (*Kellicott*).

Ægeria pini KELLICOTT, Can. Ent. Vol. XIII, 1881, pp. 5 and 158.
Harmonia pini HY. EDWARDS, Papilio, Vol. II, 1882, p. 54.

Fore wings black, with a metallic blue or green reflection. Hind wings thinly covered with black scales, transparent along the inner margin. Head, thorax and legs blue black. Collar orange. Abdomen above blue black, with an orange band on the fourth segment. Underside of abdomen wholly orange. Anal tuft orange, blue black in the middle above. Expanse, 28 mm.

Habitat: Canada and New York.

The larva lives under the bark of Pine.

Parharmonia fraxini (*Hy. Edw.*).

Carmenta fraxini HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.
Harmonia morrisoni HY. EDWARDS, Papilio, Vol. II, 1882, p. 54.
Parharmonia fraxini BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 89.

Fore wings opaque, blackish brown with a violet reflection. At end of discal cell a red cross-bar. Hind wings transparent with a narrow violet black border. Body and legs black. Antennæ yellowish before the tip. Expanse, 21–25 mm.

Habitat: New York, New Jersey, Washington, D. C., Missouri and Montana.

Parharmonia græfi (*Hy. Edw.*).

Sciapteron græfi HY. EDWARDS, Papilio, Vol. I, 1881, p. 183.
Parharmonia græfi BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 89.

Wholly black. Fore wings with a strong metallic green reflection like the female of *Sanninoidea opalescens*. Hind wings transparent with a narrow black border. Expanse, 27 mm.

Habitat: Nevada.

Podosesia syringæ (*Harr.*).

Fore wings deep brown, with a slight violet lustre; at the base two short transparent streaks and marked with red on the costa and inner margin. Hind wings transparent, thinly scaled with brown outwardly; veins brown. Head brown, palpi and collar rufous; thorax brown, with the patagia tinged with rufous. Abdomen deep brown, with a yellow spot on each side of the fourth segment. Legs yellow, broadly banded with black; femora blackish. Expanse, 26–35 mm.

Habitat: Massachusetts, New York, westward to Iowa, and southward to Texas.

This is the well-known Lilac and Ash borer. It also affects the Mountain Ash (*Pyrus americana*), according to Prof. D. S. Kellicott.

Podosesia fraxini (*Lugger*).

Trochilium fraxini LUGGER, Psyche, Vol. VI, 1891, p. 109, pl. iii, fig. 4.
Podosesia fraxini BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 88.

Closely allied to *P. syringæ*, but differs from it in having the fore wings testaceous, and the abdomen banded with yellow. The patagia are yellow at the posterior part, and the collar orange in front and yellow behind. Expanse, 27–34 mm.

Habitat: Minnesota and Montana.

The larva affects the Ash.

Sanninoidea (gen. nov.) **exitiosa** (*Say*).

This species has been erroneously referred to the genus *Sannina*, the type of which is *S. uroceriformis* Walker (see *antea*, p. 117). *S. exitiosa* belongs to a different genus, for which I would propose the name *Sanninoidea*.

This is the well-known borer which is so injurious to the Peach.

The male has the wings transparent, with steel blue borders and fringes ; the borders are sometimes scaled more or less with yellow. Head black, with a yellow patch on the vertex ; palpi yellow below, black above ; collar black, yellow in the middle on top ; thorax black, with the patagia edged internally with yellow, this color forming an angle at the anterior portion of the thorax ; metathorax with a few yellow scale-like hairs. Abdomen blue black, narrowly banded with yellow on the second, fourth, fifth and sixth segments ; anal tuft wedge-shape, black, tipped with white laterally. Legs black, with joints yellow. The female is wholly steel blue black, with the fourth and sometimes also the fifth segment orange. Hind wings transparent, broadly bordered with blue black and scaled with this color at the base, and costa and also sometimes between veins one and two, thus leaving two small clear spaces. In the female variety *fitchii* Hy. Edw. all the segments from the fourth to the last, inclusive, are orange, and in the male variety *luminosa* Neum. the borders are heavily scaled with yellow. Expanse, 22–34 mm.

Habitat: Canada to Texas

Sanninoidea opalescens (*Hy. Edw.*).

Ægeria opalescens HY. EDWARDS, Papilio, Vol. I, 1881, p. 199.
Sannina pacifica RILEY, Insect Life, Vol. III, 1891, p. 292.
Sannina opalescens BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 366.

Allied to *S. exitiosa*. The male has the outer border of the fore wing twice as broad as in *exitiosa*, and the transverse bar at the end of the discal cell is also broader. The head, palpi, thorax and abdomen lack the yellow markings. The legs are black, with only a few whitish hairs on the tibiæ and tarsi. The female is like that of *exitiosa*, but all traces of the orange bands on the abdomen are wanting and the hind wings are transparent, with only a few steel blue scales basally and a narrow outer border. Expanse, 23–33 mm.

Habitat: Nevada, Colorado and California.

Like *exitiosa* this species also affects the Peach as well as the Apricot.

I have examined the types of *Sannina pacifica*, and have found that the male of this species was previously described as *Æ. opalescens*. I am indebted to Mr. L. O. Howard for the loan of one of the type females of *S. pacifica*.

Albuna pyramidalis (*Walker*).

Ægeria pyramidalis WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 40; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. VI, 1894, p. 89.
Ægeria hylotomiformis WALKER, Cat. Lepid. Br. Mus. pl. VIII, 1856, p. 43.
Albuna hylotomiformis HY. EDWARDS, Papilio, Vol. I, 1881, p. 186.
Albuna vancouverensis HY. EDWARDS, Papilio, Vol. I, 1881, p. 188.

In the Museum Bulletin, Vol. V, 1893, p. 23, I published the following note made by the late Hy. Edwards on the type of Walker's *Æ. hylotomiformis:* "Is a good species, and is unknown to me." Since then I am informed by Mr. G. F. Hampson of the British Museum that *hylotomiformis* is the same as *Æ. pyramidalis*. Mr. Hampson's note is as follows: "That *hylotomiformis* = *pyramidalis* there is not the least doubt; the type is a female. The tinge of red on antennæ, the streak on inner area of fore wing and on each side of discocellular band, and the arrangement of yellow bands on abdomen, are quite conclusive." The species and varieties now stand as follows:[1]

ALBUNA PYRAMIDALIS *Walker*.
hylotomiformis WALKER.
vancouverensis HY. EDWARDS.
var. MONTANA *Hy. Edwards*.
tanaceti HY. EDWARDS.
var. RUBESCENS *Hulst*.
var. COLORADENSIS *Hy. Edwards*.
torva HY. EDWARDS.

Habitat: Nova Scotia, Canada, and Maine to Massachusetts, westward to the Pacific.

[1] See Bull. Am. Mus. Nat. Hist., Vol. VI, pp. 89–91.

Albuna modesta *Kellicott.*

Albuna modesta KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 46.

I have not had the opportunity of seeing this species, and therefore am not able to tell whether it is an *Albuna* or a *Sesia*. In the Museum Bulletin, Vol. VI, p. 92, I expressed the opinion that *Albuna modesta* was the same as *Sesia albicornis*, but a comparison of the types is necessary to definitely decide this question.

Sesia giliæ (*Hy. Edw.*).

Ægeria giliæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 200.
Albuna vitrina NEUMOEGEN, Ent. News, Vol. II, 1891, p. 109.
Ægeria deceptiva BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 93.

The type of *S. giliæ* is a female, and the species described as *Albuna vitrina* is a male, and is in my opinion nothing more than the male of the former. *Vitrina* is not an *Albuna*, but must be referred to the genus *Sesia*. In the Museum Bulletin, Vol. VI, p. 367, I erroneously united *vitrina* with *Albuna pyramidalis*, considering it to be merely one of the varieties of the latter species. Since then I have had the opportunity of examining the type of *vitrina*, and find that it is distinct from *Albuna pyramidalis*, and that the species described by me as *Ægeria deceptiva* is the same as *vitrina*. The original description of *vitrina* is misleading, no mention being made of the yellow bands on the abdomen.

Male.—Head blackish brown, front whitish ; palpi yellow mixed with black hair outside ; thorax blackish, with the posterior edge of the patagia yellow ; abdomen blackish with a yellow band on the second, fourth, sixth and seventh segments ; anal tuft black on top, yellow beneath and in the middle above. Legs yellow with a black band on the tibiæ ; femora black. Underside of abdomen with the bands from above repeated and the segments between scaled with yellow. Wings transparent with narrow blackish brown borders and discal bar. Underside of wings with costal border and discal bar yellow. Expanse, 20 mm.

Female.—Like the male, but differs as follows : Palpi wholly yellow ; margins of wings brown ; discal bar with an orange spot. Abdomen with a yellow band on the upper side of the second, fourth and sixth segments ; underside of abdomen similar to that of the male. Expanse, 24–29 mm.

Habitat : Colorado, Montana, and Calgary, British Columbia.

Sesia mellinipennis *Boisduval.*

Sesia mellinipennis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 402, pl. xiv, 10 B. fig. 12; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 96.
Albuna resplendens HY. EDWARDS, Papilio, Vol. I, 1881, p. 186.
Albuna artemisiæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 187.
Ægeria senecioides HY. EDWARDS, Papilio, Vol. I, 1881, p. 198.

The types of *Albuna artemisiæ* and *Ægeria senecioides* are before me. Both are males and undoubtedly the same species. The only differences are that *artemisiæ* has the bands on the abdomen more distinct and the margins of the wings darker brown. This may be from the more perfect condition of the insect, *senecioides* being somewhat worn through age or flight. *Albuna resplendens* was described as a male, but the type is a female, and I consider it the same as *artemisiæ.* It also agrees very well with the species described and figured by Boisduval as *Sesia mellinipennis*, and I would propose to unite it with this latter species.

Habitat: California and Nevada.

Sesia rileyana (*Hy. Edw.*).

Albuna rileyana HY. EDWARDS, Papilio, Vol. I, 1881, p. 187.
Ægeria hyperici HY. EDWARDS, Papilio, Vol. I, 1881, p. 195.

Albuna rileyana was described from a single female specimen, and *Ægeria hyperici* from two examples, as females, but the types are males, and are undoubtedly the same as *rileyana.* The species fits better in the genus *Sesia* than in *Albuna.* The wings are largely transparent with narrow brown borders. The discocellular spot is bright orange red; palpi yellow, with a few black hairs at the sides; abdomen black with six narrow yellow bands. Expanse, 19–25 mm.

Habitat: West Virginia, Missouri and Kansas.

Sesia brunneipennis (*Hy. Edw.*).

Ægeria brunneipennis HY. EDWARDS, Papilio, Vol. I, 1881, p. 191.

The type of this species, from the Tepper Collection in the Michigan Agricultural College, was kindly sent to me for examination by Prof. Barrows through the kindness of Mr. G. C. Davis. The insect is closely related to, if not identical with, *S. rileyana.* It differs from it by having the brown margins of the fore wing much broader, thus making the wings more opaque. The outer portion is almost entirely opaque, with only a few short transparent streaks in the area beyond the orange discocellular spot. This space in *rileyana* is largely transparent. Abdomen with five yellow bands. Expanse, 23 mm.

Habitat: West Virginia and North Carolina.

Sesia mimuli (*Hy. Edw.*).

Ægeria mimuli Hy. Edwards, Papilio, Vol. I, 1881, p. 200.

Closely allied to *S. rileyana*, but the bands on the abdomen are pale yellowish white instead of bright yellow. The front of the head is white, as are also the scales on the palpi. The markings on the wings above and beneath are also paler. It is possible that this species may prove to be a climatic variety of *rileyana.* Expanse, 21 mm.

Habitat: Colorado.

Sesia rutilans (*Hy. Edw.*).

Albuna rutilans Hy. Edwards, Papilio, Vol. I, 1881, p. 186; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.
Ægeria aureola Hy. Edwards, Papilio, Vol. I, 1881, p. 194.
Ægeria hemizoniæ Hy. Edwards, Papilio, Vol. I, 1881, p. 198.
Ægeria lupini Hy. Edwards, Papilio, Vol. I, 1881, p. 192; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 91.
Ægeria perplexa Hy. Edwards, Papilio, Vol. I, 1881, p. 192.
Ægeria impropria Hy. Edwards, Papilio, Vol. I, 1881, p. 193.
Ægeria washingtonia Hy. Edwards, Papilio, Vol. I, 1881, p. 197.
Ægeria madariæ Hy. Edwards, Papilio, Vol. I, 1881, p. 201 (in part).

Male.—Head black; palpi yellow, with a black stripe outside; collar and underside of thorax yellow; thorax above black with the patagia tipped with yellow at the posterior end. Legs yellow banded with black. Fore wings broadly bordered with blackish brown; between the veins, along the outer border, are traces of yellowish rays. The basal transparent space is small and triangular ; discocellular spot large with the clear space beyond small and round. Hind wings transparent, bordered with blackish brown and a few yellow hairs at the base of the inner margin. Abdomen blackish brown with a rather broad yellow band at the posterior edge of the second and fourth segments. Underside of fore wings streaked with golden yellow between the veins of the opaque portion ; hind wings with a narrow golden yellow border preceding the brown fringes. Abdomen edged along each side with yellow points. Anal tuft flat, black above, orange at the sides and middle beneath. Expanse, 18–21 mm.

Female.—Head black ; palpi and collar yellow ; thorax black above, with a yellow stripe along each side and a small transverse spot on the posterior portion; thorax beneath yellow. Abdomen black, a yellow band on the second, fourth, fifth and sixth segments, sometimes the band on the fifth segment wanting. Legs yellow, banded with black ; tarsi yellow. Fore wings blackish brown, bright orange between the veins. The orange scales almost obscure the transparent portions of the wings. Hind wings transparent, very narrowly bordered with brown and golden yellow ; fringes brown. Anal tuft bunch-like, yellow, black at the base in the middle above. Underside of fore wings almost entirely clear pale orange yellow with only the discocellular spots, the outer veins and fringes brown. Hind wings with the orange border broader than above. Abdomen with the bands repeated. Expanse, 17–21 mm.

Habitat: California, Nevada, Washington, Texas and Colorado.

The above descriptions were taken from three bred males and three females from the collection of the U. S. National Museum, sent me through the kindness of Mr. L. O. Howard. The species lives in the roots of the Strawberry, as recorded by the late C. V. Riley (Proc. Ent. Soc. Wash., Vol. I, p. 85).

Mr. J. J. River has bred the species from the roots of the garden Raspberry and cultivated Blackberry (Ent. Amer., IV, p. 99). He also states that the male sometimes has three abdominal bands of pale yellow, and when three are present the third is at the base of the anal tuft. Another variation shows a tendency in the male to imitate the dorsal markings of the female by having well-developed bands on the second, fourth and sixth segments, and on the dorsum of all the other segments is to be seen a cluster of yellow scales, forming a nucleus of a yellow band.

The species described as *perplexa*, *lupini*, *impropria* and *washingtoniæ* are males, and *hemizoniæ*, *areola* and *rutilans* are the females. The specimen described as the male of *madariæ* is the male of *rutilans*, and the female is probably a distinct species.

Sesia madariæ (*Hy. Edw.*).

Ægeria madariæ Hy. Edwards, Papilio, Vol. I, 1881, p. 201.

Head black, collar and palpi yellow; thorax black, with a yellow stripe along the inner edge of the patagia, and a yellow mark at the posterior edge. Abdomen with a yellow band on the second and fourth segments. Fore wings purplish black, with the transparent spaces very small. Hind wings transparent, with the violet black border narrow. Underside of fore wings largely golden yellow. Expanse, 15 mm.

Habitat: California.

Two females of this species are in the Hy. Edwards Collection, and they look very much like the male of *Sesia rutilans.*

Sesia neglecta (*Hy. Edw.*).

Ægeria neglecta Hy. Edwards, Papilio, Vol. I, 1881, p. 197.

Allied to *S. madariæ*, but the fore wings are almost entirely opaque, with only a very small transparent space in the cell and beyond the discal spot; between the veins on the outer portion the fore wings are streaked with dull yellow. Otherwise it is the same as *S. madariæ*, and is probably the same species, but more material is required to verify my suspicion. Expanse, 16 mm.

Habitat: Washington, California and Nova Scotia.

Sesia refulgens (*Hy. Edw.*).

Ægeria refulgens Hy. Edwards, Papilio, Vol. I, 1881, p. 199.

Head and antennæ black; palpi and collar yellow; thorax black, with a yellow band across the posterior portion and a few yellow hairs at the posterior end of the patagia. Abdomen black, with a yellow band on the second, fourth and sixth segments, and faint traces of another yellow band on the fifth segment. Anal tuft black, yellow at the sides above. Legs yellow and black, femora black, tibiæ yellow, with a black band. Fore wings violet brown, marked with orange in the transparent portion; discal spot orange outside. Hind wings transparent, with a narrow violet brown border. Underside of fore wings bright orange between the veins and along the costa of the hind wings. Expanse, 18 mm.

Habitat: Georgia.

The type is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me for examination by Prof.

Barrows. It is a female and not a male, as described by Hy. Edwards. It is closely related to *S. rutilans*, but the fore wings are narrower, and the discal spot is orange outside and the patagia are tipped with yellow. It also lacks the orange on the border of the hind wings.

Sesia novaroënsis (*Hy. Edw.*).

Ægeria novaroënsis BEHRENS MS. HY. EDWARDS, Papilio, Vol. I, 1881, p. 199.

Head, palpi and collar bright orange; thorax above black, patagia orange, as is also the underside. Abdomen black, with a bright orange band on each segment; underside of abdomen wholly orange. Legs orange, with black rings. Fore wings transparent, with a blue black narrow border; transverse discal spot blue black. Hind wings transparent, with a narrow blue black border. Expanse, 30–35 mm.

Habitat: California and Oregon.

The specimen described by Hy. Edwards as the male of this species is a female. It is the largest *Sesia* known in this country at present. The male is unknown.

Sesia bassiformis *Walker*.

Ægeria (*Paranthrene*) *bassiformis* WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 39.
Trochilium (*Paranthrene*) *bassiformis* MORRIS, Synop. Lepid. N. Am. 1862, p. 331 (quotes Walker).
Sesia bassiformis BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 434 (quotes Walker).
Ægeria bassiformis BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 24.

In the Museum Bulletin, Vol. V, p. 25, and Vol. VI, p. 92, I united *Æ. sexfasciata*, *consimilis*, *eupatori*, *infirma* and *bolli* with *Æ. lustrans* after an examination of the types. Since then the type of *Æ. imitata* was examined, and the insect must also be referred to *lustrans*. In my opinion *Æ. bassiformis* Walker is nothing more nor less than a worn example of the male of *Æ. lustrans*. Mr. Hy. Edwards's note on the type of *bassiformis*,[1] which was seen by him in the British Museum, is as follows: "It is very like *Ægeria lustrans* Gr., but blacker. This may be

[1] Bull. Am. Mus. Nat. Hist., Vol. V, p. 24.

from imperfect condition. It has four narrow bands on the abdomen, and one a little wider at the base." Recently I received from Mr. Hampson a colored sketch of the type of *bassiformis*, and it agrees very well with the types of *Æ. eupatori* and *Æ. consimilis*, both of which are worn examples of *Æ. lustrans.* I therefore propose to unite *lustrans* with *bassiformis.* The bands of this insect soon become abraded through flight, after it emerges from the pupa, and the older the insect becomes the blacker it gets, and as a consequence specimens may be found with one, two, three, or the usual number (six) bands, or without any. Thus more or less worn individuals may be readily mistaken for different species. The larva lives in the stems of *Eupatorium.*

The synonomy of the species is now as follows :

SESIA BASSIFORMIS *Walker.*
lustrans GROTE.
sexfasciata HY. EDW.
consimilis HY. EDW.
eupatorii HY. EDW.
infirma HY. EDW.
imitata HY. EDW.

Habitat : Massachusetts and New York to Texas.

Sesia rubrofascia (*Hy. Edw.*).

Ægeria rubrofascia HY. EDWARDS, Papilio, Vol. I, 1881, p. 191.
Ægeria bolteri HY. EDWARDS, Papilio, Vol. III, 1883, p. 155.

Ægeria bolteri was originally described as a male, but the type which is before me is a female, and I regard it as the female of *Ægeria rubrofascia.* Expanse, 18–20 mm.

Habitat : Georgia and Northern Illinois.

Sesia pictipes (*Hy. Edw.*).

Ægeria pictipes GROTE & ROBINSON, Trans. Amer. Ent. Soc. Phila. Vol. II, 1868, p. 182.
Ægeria inusitata HY. EDWARDS, Papilio, Vol. I, 1881, p. 201.

Both sexes of this species are very much alike, and resemble the male of *Sanninoidea exitiosa*, of which the female has opaque wings. *S. pictipes* has the wings largely transparent, the border blue black and very narrow. The abdomen is blue black, with a very narrow yellow band on the upper side of the second segment and one on the underside of the fourth segment, by means of which it may be readily separated from *exitiosa*. The latter also has a wedge-shaped anal tuft, while that of *pictipes* is merely a straight bunch of hairs. The larva lives under the bark of Plum, Wild Cherry (*Prunus serotina*), *Prunus pennsylvanicus*, Juneberry (*Amelanchier canadensis*) and Beach Plum (*Prunus maritima*). Expanse, 17–26 mm.

Habitat: Canada, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Illinois and California.

Sesia fulvipes (*Harris*).

Ægeria fulvipes HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 312.

Head black, antennæ orange before the tip, beneath palpi orange, black inside; thorax black, with an orange spot on each side beneath. Abdomen black, with the three basal segments beneath orange. Legs orange, with the femora black. Wings with very narrow black borders. The female has the outer border of the fore wings somewhat broader than the male, and the first two segments are black in the middle and orange at the side, third segment wholly orange; the abdomen above is wholly black, as in the male. Expanse, 22 mm.

Habitat: Massachusetts and Canada.

Sesia saxifragæ (*Hy. Edw.*).

Ægeria saxifragæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 190; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1895, p. 91.
Ægeria henshawi HY. EDWARDS, Papilio, Vol. II, 1882, p. 56.

Allied to *S. fulvipes*, but differs from it by having the abdomen wholly black above and below, the borders of the fore wings broader, and by the absence of the orange before the tip of the antennæ beneath. At the base of the wings are a number of orange scales, as well as on the underside of the fore wings. Expanse, 20–22 mm.

Habitat: Labrador and Colorado.

Sesia albicornis (*Hy. Edw.*).

Ægeria albicornis HY. EDWARDS, Papilio, Vol. I, 1881, p. 201 ; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 92.
Ægeria proxima HY. EDWARDS, Papilio, Vol. I, 1881, p. 201.

Male.—Head black, palpi white beneath ; antennæ black, sometimes with a white patch before the tip ; thorax black with a narrow yellow line on each side, and a yellow spot on each side beneath. Abdomen black above, steel blue black beneath ; anal tuft black edged with white on each side and white in the middle beneath. Legs steel blue, fore coxa white, and the spurs and tufts on the joints white. Fore wings with the outer border sometimes marked with yellow between the veins ; costal margin narrow ; transverse discal mark violet black. Underside of fore wings streaked with yellow in the opaque portion. Hind wings transparent, with a narrow black border. Expanse, 17–19 mm.

Female.—Wholly bronzy black, with the antennæ marked more or less with white before the tip. Costa on the fore wings beneath scaled with yellow. Legs with the joints tufted with white, spurs also white. Expanse, 22 mm.

Habitat: New York to California and Oregon.

The species has been reared from larvæ found under the bark of Willow (Proc. Ent. Soc. Wash., Vol. I, p. 85). I have also bred it from the trunks of low willows, which were infested with *Cryptorhynchus lapathi.* In a female example from Colorado the palpi are pale yellow beneath instead of black.

Sesia culiciformis var. americana, var. nov.

Ægeria culiciformis BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 93.

Wings transparent, with the black margins and discal transverse mark on the fore wings metallic blue black. Head, antennæ, thorax and rest of body also metallic blue black, except the base of fore wings and the palpi orange ; the fourth segment of the abdomen is red above and below, and on each side of the thorax beneath is an orange spot. The tarsi are also slightly tinged with pale orange. In one example there is a red stripe on each side of the abdomen from the base to the red fourth segment. Expanse, 21–24 mm.

Habitat: Nevada and British Columbia.

This form was first recorded by me as occurring in this country from a specimen in the collection of Mr. Charles Palm, from the Cascade Mountains, British Columbia.

It differs from the typical European *culiciformis* by the absence of the orange scales at the base of the fore wings above, and by having only the base of the fore wings beneath orange, while in the European form the dark portion beneath is almost entirely golden orange yellow. It also differs by having the legs entirely blue black, and lacking the pale orange patch on the hind tibiæ. It is also darker and more metallic blue. Since the record of this variety I have received from Mr. H. F. Hillman, from Reno, Nevada, a branch of Alder, from which emerged four specimens of this beautiful insect.

Sesia tepperi (*Hy. Edw.*).

Pyrrhotænia tepperi HY. EDWARDS, Papilio, Vol. I, 1881, p. 203.

Head orange, with a white spot before each eye ; palpi, thorax above and below, underside of abdomen, first segment above and anal tuft deep orange ; remaining segments above blue black. Fore wings metallic blue black, cell transparent ; area beyond discal spot very small. Expanse, 22 mm.

Habitat: Georgia.

The type is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me by Prof. Barrows. It is a female, and not a male, as described by Hy. Edwards, and is generically the same and allied to *S. culiciformis*.

Sesia aureopurpurea (*Hy. Edw.*).

Ægeria (?) *aureopurpurea* HY. EDWARDS, Bull. Brooklyn Ent. Soc. Vol. III, 1880, p. 72.

Fore wings opaque, violet brown, with a few short, yellow streaks before the outer margin. Hind wings transparent, border narrow, violet brown. Head black, palpi yellow. Thorax blackish brown, with a narrow yellow stripe on each side. Abdomen violet brown, with a narrow yellow ring on the first, second, fourth and anal segments. Anal tuft violet brown, yellow in the middle beneath. Antennæ with a white patch before the tip. Undersides of wings same as above, but the fore wings are much brighter and more metallic. Expanse, 12 mm.

Habitat: Texas.

Sesia acerni (*Clem.*).

This is the well-known Maple borer, to which trees the larvæ are especially destructive. The moth emerges early in the morning and flies as soon as the wings are expanded and dried. The male moth, according to Mr. L. H. Joutel, when in search of the female, flies up and down the trunk of the tree, very much like the males of the Ichnenmon Fly (*Thalessa lunator*).

Sesia corni (*Hy. Edw.*).

Ægeria corni HY. EDWARDS, Papilio, Vol. I, 1881, p. 190; KELLICOTT, Can. Ent. Vol. XXIV, 1892, pp. 46 and 210; Insect Life, Vol. V, 1892, p. 83.

Male.—Head black, palpi orange, last joint black outside; collar orange; antennæ black, with a whitish patch outside before the tip; thorax black above; patagia mixed with yellow hairs; yellow beneath; abdomen black, with a very narrow yellow ring at the posterior edge of the second, fourth, fifth and sixth segments; underside of last three segments pale yellow; anal tuft orange, black above and laterally at the base; coxæ yellow, femora, tibiæ and tarsi black, yellow inwardly, spurs yellow. Fore wings transparent, costa with a narrow black margin, apical portion broadly black; discal mark large and broad. Hind wings transparent, with a very narrow black border. Expanse, 17–20 mm.

Habitat: New York, Massachusetts and Ohio.

Allied to *S. acerni.* According to Prof. D. S. Kellicott, the female is the same as the male in general color, but differs in having less black at the tips of the palpi, and in having much more golden on the abdomen beneath, this color extending over the dorsum so that nearly all the segments are faintly edged, and the fourth has a broad band. It also lacks the black in the anal tuft, which is reddish orange. A female in the collection of Rev. J. L. Zabriskie has the bands on the abdomen all very narrow. The larva lives under the bark of Maple.

Sesia tipuliformis (*Linn.*).

This well-known species is found in this country from the Atlantic to the Pacific coast. In its larval stage it lives in the stems of the cultivated Currant, and according to Dr. Staudinger it also lives in the young shoots of Hazel (Stettin Ent. Zeitsch., Vol. XVII, p. 202).

Sesia pyri (*Harris*).

Trochilium pyri HARRIS, New England Farmer, Vol. IX, 1830, p. 2.
Ægeria pyri HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 313.
Sesia pyri BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 440.
Ægeria kœbelei HY. EDWARDS, Papilio, Vol. I, 1881, p. 196.

Male.—Head black, orbits white; palpi yellow beneath, black above; antennæ with a dull yellow patch before the tip, but mostly always entirely black. Thorax black above, yellow at the sides beneath. Abdomen blue black, with a narrow yellow ring at the posterior edge of the second and fourth segments; underside of abdomen washed with yellow; anal tuft black, slightly yellow in the middle beneath. Fore wings narrow, margins and the discal bar bronzy brown. Expanse, 14 mm.

Female.—Larger than the male, with a clear pale yellow patch on the outside of the antennæ before the tip. Abdomen with a narrow yellow band on the second segment and a broader one on the fourth segment. On the first and second segments laterally is a short yellow stripe. Fourth segment beneath wholly yellow. Anal tuft black, with a bunch of yellow hairs on each side above. Legs largely black, with narrow yellow bands. The underside of the fore wings with more and brighter yellow along the costa and outer portion. Expanse, 18 mm.

Habitat: Canada to Florida, and westward.

The type of *Æ. kœbelei* I regard to be nothing more than a worn male of *Sesia pyri.* The larva lives under the bark of Pear and Apple.

Sesia scitula (*Harris*).

Ægeria scitula HARRIS, Am. Journ. Sci. and Arts, Vol. XXXVI, 1839, p. 313; WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 45; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.
Trochilium scitula MORRIS, Synop. Lepid. N. Am. 1862, p. 141.
Sesia scitula BOISDUVAL, Suites à Buffon, Nat. Hist. Lépid. 1874, p. 439.
Trochilium gallivorum WESTWOOD, Gardener's Chronicle, 1854, p. 757; Proc. Ent. Soc. Lond. (2) III, 1854, p. 21; HY. EDWARDS, Papilio, Vol. II, 1882, p. 97; KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 45.
Trochilium hospes WALSH, Proc. Ent. Soc. Phila. Vol. VI, 1866, p. 270; PACKARD, Fifth Rep. U. S. Ent. Comm. 1890, pp. 217, 270 and 296.
Ægeria æmula HY. EDWARDS, Papilio, Vol. III, 1883, p. 155.

Male.—Head black, with a silvery white line before each eye; palpi yellow, tip black; antennæ steel blue black; thorax blue black, with a narrow yellow line on the patagia. Abdomen steel blue black, with a narrow yellow band on posterior edge of the second segment above and a broader band on the sixth segment, which is also present on the underside ; anal tuft black, yellow at the sides ; at the base of the abdomen on each side is a short narrow yellow stripe terminating at the band in the second segment. Legs yellow, middle and hind femora black, and a purple band at the end of the middle and hind tibiæ. Fore wings transparent, costal border very narrow, outer border broader and marked with yellow between the veins ; discal bar narrow, violet. Hind wings with border very narrow. Undersides of the wings similar to the upper ; underside of abdomen marked with yellow on the last three segments. Expanse, 19–20 mm.

Female.—Similar to the male, but larger and heavier. The palpi are wholly yellow and the fourth segment is wholly yellow above and below ; the fifth and sixth are yellower beneath ; on the fore wings the yellow between the veins of the outer border is also more distinct, and the anal tuft is yellow at the sides above. Expanse, 22 mm.

Habitat: New York, New Jersey, Virginia, Massachusetts, Canada and Illinois.

This species has been bred from Oak Galls (*Andricus cornigerus*) by Rev. J. L. Zabriskie, and by me from under bark of Chestnut. Walsh bred it from a Willow gall, and specimens from Oak and Hickory galls, which he doubtfully referred to *S. scitula* (*hospes*). Mr. L. H. Joutel bred it from the trunk of Dogwood (*Cornus florida*). It is closely allied to *S. pyri*, but the legs are largely yellow ; the thorax has a yellow stripe on each side ; the antennæ lack the white patch, and the female has the fourth segment wholly yellow above and below. The types of *Ægeria æmula* from the Riley Collection were sent to me by Mr. Howard, and they are the males of *scitula*. Dr. Riley bred them from larvæ found in November under the bark of an old Oak. They emerged May 22 and 24.

Sesia corusca (*Hy. Edw.*).

Ægeria corusca HY. EDWARDS, Papilio, Vol. I, 1881, p. 193.

Bronzy brown, with a violet reflection. Head bluish black, white in front ; palpi yellow ; collar yellow ; thorax with a narrow yellow line laterally ; abdomen with a narrow yellow band on the first, second, third, fourth and sixth segments. Anal tuft yellow at the sides. Fore wings with transparent area beyond the discal mark, small and round ; outer portion streaked with yellow between the veins. Expanse, 14 mm.

Habitat: Texas.

Allied to *S. pyri*, but differs by the bands on the abdomen and in having the outer transparent space on the fore wings round, while in *pyri* it is quadrate.

Sesia decipiens *Hy. Edw.*

Ægeria decipiens HY. EDWARDS, Papilio, Vol. I, 1881, p. 187.
Ægeria nicotianæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 202.

In this Bulletin, Vol. VI, p. 367, I united *Ægeria imperfecta* with *Ægeria decipiens*, there being no sufficient characters to warrant their separation as distinct species. Since then I have carefully studied the type of *Ægeria nicotianæ* and find that it must also be referred to *decipiens*. It only differs by being somewhat smaller. *Decipiens* and *nicotianæ* are males, while *imperfecta* is undoubtedly the female.

Habitat: Colorado and Texas.

Sesia rubristigma (*Kellicott*).

Ægeria rubristigma KELLICOTT, Can. Ent. Vol. XXIV, 1892, p. 212; Insect Life, Vol. V, 1892, p. 84; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 94.

An example of this species was kindly sent to me by Prof. D. S. Kellicott, who bred the same from the galls on Oak (*Quercus palustris*). It is a good species, allied to *S. decipiens*, and not identical with the example recorded by the late Hy. Edwards as the European *asiliformis*, as I supposed.

Habitat: Ohio.

Sesia querci (*Hy. Edw.*).

Ægeria querci HY. EDWARDS, Papilio, Vol. II, 1882, p. 98.

Allied to *decipiens*, but a much more delicate insect. The margins of the wings are very narrow and the antennæ are thicker. The palpi are black outside and white inside and at the tip. The abdomen has five yellow bands, the one on the fourth segment almost as broad as the segment. Expanse, 12 mm.

Habitat: Arizona.

The Moth has been bred from galls found on Live Oak.

Sesia prosopis (*Hy. Edw.*).

Ægeria prosopis HY. EDWARDS, Papilio, Vol. II, 1882, p. 99.

A good species and different from all the known American species. It has the margins of the wings, head, antennæ and body deep black. The palpi are white beneath, with the last joint and above black. The legs are black, with the coxæ of the anterior pair, joints and spurs white. The fringes of the hind wings are also white. Has been raised from galls found on Mesquite.

Habitat: Arizona.

Sesia tecta (*Hy. Edw.*).

Ægeria tecta HY. EDWARDS, Papilio, Vol. II, 1882, p. 56.

The type is in the Neumoegen Collection and has been examined by me. It is allied to *S. rubristigma*. The margins of the wings are very narrow; the discal bar is straight, very narrow, and yellow outside. The black abdomen has four yellow bands, one on the second segment, a broader one on the fourth segment, and one on each of the sixth and seventh segments. Expanse, 16 mm.

Habitat: Arizona.

Sesia morula (*Hy. Edw.*).

Ægeria morula HY. EDWARDS, Papilio, Vol. I, 1881, p. 196.

Only a single specimen of this species is known to exist, and the type is in the Neumoegen Collection. It is a distinct species.

Habitat: Texas.

Sesia verecunda (*Hy. Edw.*).

Ægeria verecunda HY. EDWARDS, Papilio, Vol. I, 1881, p. 190.

A very distinct and aberrant species. The types are females and the male is unknown, and when known probably a new genus will have to be erected for the species.

Habitat: Colorado.

Sesia edwardsii *Beuten.*

Ægeria edwardsii BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 92.

A distinct species allied to *Sesia verecunda*.

Habitat: Colorado.

Sesia candescens (*Hy. Edw.*).

Ægeria candescens HY. EDWARDS, Papilio, Vol. II, 1882, p. 123.

Only known by a single male in the Neumoegen Collection. It is a good species.

Habitat: Arizona.

Pyrrhotænia behrensii *Hy. Edw.*

Pyrrhotænia behrensii HY. EDWARDS, Papilio, Vol. II, 1882, p. 123; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26.
Pyrrhotænia elda HY. EDWARDS, Ent. Am. Vol. I, 1885, p. 49.

The specimens described as *P. behrensii* are the males of *P. elda.*

Male.—Head black, with a green lustre; palpi red; thorax metallic blue black; fore wings opaque, metallic blue black, inner margin bright red. Hind wings transparent, with a very narrow border, fuscous, bright red at the base along the inner margin. Abdomen blue black on the back of the first, second and third segments; remaining parts of the abdomen bright red. Anal tuft blackish on each side above. Expanse, 19–22 mm.

Female.—Similar to the male, but the hind wings are entirely covered with bright red scales.

Habitat: California.

Pyrrhotænia fragariæ *Hy. Edw.*

Pyrrhotænia fragariæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 202; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26, and Vol. VI, 1894, p. 95.
Pyrrhotænia helianthi HY. EDWARDS, Papilio, Vol. I, 1881, p. 203.
Pyrrhotænia orthocarpi HY. EDWARDS, Papilio, Vol. I, 1881, p. 204.

In the Museum Bulletin, Vol. V, p. 26, and Vol. VI, p. 95, *P. helianthi* and *P. orthocarpi* were united by me with *P. fragariæ.*

Male.—Head black; palpi orange; thorax metallic green; posterior tips of patagia orange; abdomen metallic green black; fourth, sixth and seventh segments on top and lateral edges of all the segments orange red; anal tuft orange red, black on each side above. Fore wings with borders and transverse discal mark metallic green black; transparent space in cell small, triangular, and the space beyond the discal mark rounded with the veins marked with green black; along the inner margin to about the middle of the wing runs an orange red streak. Hind wings transparent, costal margin orange, outer border fuscous. Expanse, 19 mm.

Female.—Similar to the male, but the fore wings are covered with metallic blue black scales, sometimes showing very slight traces of transparent spaces.

Hind wings transparent basally and orange outwardly, with the border and fringes fuscous. Expanse, 19–22 mm.

Habitat: Colorado and Nevada.

Pyrrhotænia præstans (*Hy. Edw.*).

Ægeria præstans HY. EDWARDS, Papilio, Vol. II, 1882, p. 98.

This species looks much like *P. fragariæ*, but is larger, and is marked with orange in the cell and streaked with this color in the area beyond the discal mark. Expanse, 23 mm.

Habitat: Washington.

The type, a single male, is in the Neumoegen Collection.

Pyrrhotænia polygoni *Hy. Edw.*

Pyrrhotænia polygoni HY. EDWARDS, Papilio. Vol. I, 1881, p. 202; BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 95.
Pyrrhotænia meadii HY. EDWARDS, Papilio, Vol. I, 1881, p. 204.

This species was erroneously described as a male. The type is a female, and the examples described as *P. meadii* I consider to be the males of *P. polygoni*.

Male.—Head and thorax metallic blue or green black; palpi bright red, tips black; thorax beneath with a red spot on each side anteriorly; abdomen metallic blue or green black; fourth, sixth and seventh segments bright red; lateral edge of abdomen also red; underside blue black. Fore wings metallic blue or green black; inner margin, to a little beyond the middle of the wing, red. Expanse, 18–20 mm.

Female.—Like the male, but has the hind wings red with a narrow border and fringes fuscous. Thorax with a red stripe on each side. Expanse, 20 mm.

Habitat: California.

Pyrrhotænia achillæ *Hy. Edw.*

Pyrrhotænia achillæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 203.
Pyrrhotænia eremocarpi HY. EDWARDS, Papilio, Vol. I, 1881, p. 203.

The only difference between the types of *P. achillæ* and *P. eremocarpi* is in size. Their markings and colors are absolutely identical. The expanse of *achillæ* is 15 mm., and of *eremocarpi* 18 mm. The insect is entirely metallic blue black, except the palpi at base, a spot on each side of the anterior part of thorax beneath, tips of patagia, a streak along inner margin of fore wings, and the middle of the anal tuft, red.

Habitat: California.

Pyrrhotænia texana *Hy. Edw.*

Pyrrhotænia texana Hy. Edwards, Papilio, Vol. I, 1881, p. 204; Beutenmüller, Bull. Am. Mus. Nat. Hist. Vol. V, 1893, p. 26.
Pyrrhotænia wittfeldii Hy. Edwards, Papilio, Vol. III, 1883, p. 156.

Male.—Head black; palpi orange; collar orange; thorax brown with an orange red stripe on each patagia and a transverse mark of the same color on the posterior edge of the thorax; abdomen brown, with an orange red band on the second, fourth, sixth and seventh segments; anal tuft mixed with orange hairs beneath; abdomen beneath orange from the fourth to the last segment. Fore wings brown with the transparent spaces quite small. Hind wings transparent, border very narrow. Expanse, 19–21 mm.

Female.—The fore wings are opaque, brown, without the transparent spaces, and the abdomen lacks the orange red band on the sixth segment; anal tuft without orange hairs beneath, otherwise same as the male. Expanse, 22 mm.

Habitat: Florida and Texas.

Pyrrhotænia floridensis *Grote.*

Pyrrhotænia floridensis Grote, Can. Ent. Vol. VII, 1875, p. 174.

Male.—Head brown, palpi and collar orange red; thorax brown with an orange red spot on each side beneath and an orange red mark on the posterior edge of the thorax above. Abdomen brown with an orange red band on the second, fourth, sixth and seventh segments; anal tuft brown. Fore wings deep brown, orange red in the cell and in the area beneath the median vein; beyond the indistinct discal mark the wing is also streaked with orange red. Hind wings transparent, border brown, narrow. Legs alternately blue black and orange red. Expanse, 14 mm.

Female.—Similarly colored as the male, but the discal spot is distinctly orange, and the abdomen lacks the band on the sixth segment. It is also larger and the wings are broader. Expanse, 18 mm.

Only the type male has hitherto been known. The female was given to us by Mrs. A. T. Slosson, who captured three examples in Florida on Scrub Oaks.

Pyrrhotænia geliformis (*Walker*).

Ægeria geliformis Walker, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 46.
Pyrrhotænia geliformis Grote, New Check List of Moths, 1882, p. 12.

Head, thorax, legs, fore wings and first segment black with a violet blue reflection, remaining segments of abdomen above and below bright red; anal tuft mixed with a little black. Expanse, 15 mm.

Habitat: Florida and Mexico.

Pyrrhotænia sapygæformis (*Walker*).

Ægeria sapygæformis WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 45.
Pyrrhotænia sapygæformis GROTE, New Check List of Moths, 1882, p. 12.

Allied to *P. geliformis.* Head black, palpi and collar red; thorax black with a red mark posteriorly above and a red spot on each side of the anterior part beneath. Abdomen black, fourth to last segments red above and below; anal tuft black. Legs black and red. Fore wings marked with red in the cell and beneath the median vein. Expanse, 17–19 mm.

Habitat: Florida.

Pyrrhotænia animosa *Hy. Edw.*

Pyrrhotænia animosa HY. EDWARDS, Papilio, Vol. III, 1883, p. 156.

Male.—Head black; palpi red mixed with black hairs; thorax black, posterior half of patagia red, also a red spot on each side beneath; abdomen blackish, sixth and seventh segments red; lateral edge of abdomen red from fourth to the last segment; anal tuft black laterally. Fore wing greenish black, with a red streak along the inner margin. Hind wings transparent, border narrow, blackish. Expanse, 20 mm.

Female.—Differs from the male by being wholly greenish black, except the palpi, inner margin and fore wings and lateral edge of abdomen red. Expanse, 17–19 mm.

Habitat: Arizona.

Pyrrhotænia subærea *Hy. Edw.*

Pyrrhotænia subærea HY. EDWARDS, Papilio, Vol. III, 1883, p. 156.

Head and thorax deep brown; antennæ with a yellow spot one-third before the tip; palpi yellowish, abdomen brownish, scaled with yellow, and with traces of bands on the fourth, fifth, sixth and seventh segments; anal tuft mixed with yellow; thorax with a yellow spot on each side of the posterior part. Fore wings purplish brown sprinkled with yellow scales; hind wings purplish brown, transparent at the base; all the wings beneath sprinkled with yellow scales. Expanse, 14 mm.

The type is in the Neumoegen Collection, and is in poor condition, and the original description is too brief for recognition of the species. The above description was taken from a male in fair condition sent to me by Prof. Barrows.

Habitat: Arizona.

Carmenta pyralidiformis (*Walker*).

Ægeria pyralidiformis WALKER, Cat. Lepid. Br. Mus. pt. VIII, 1856, p. 44.
Carmenta pyralidiformis HY. EDWARDS, Papilio, Vol. I, 1881, p. 184.
Sesia nigella HULST, Bull. Brooklyn Ent. Soc. Vol. III, 1881, p. 75.

Violet brown ; palpi and collar yellow ; thorax with a narrow yellow stripe on each patagia, and a yellow spot on each side of the thorax beneath. Abdomen with the fourth segment bright yellow in the female and in the male with an additional narrow yellow ring on the sixth segment. Fore wings opaque ; hind wings transparent. Expanse, 15–21 mm.

Habitat: Canada to Texas.

Carmenta sanborni *Hy. Edw.*

Carmenta sanborni HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.

Bronze black. Fore wings opaque, with a very small white space beyond the cell ; beneath they are yellow for about their basal half and the white spot from above repeated. Hind wings transparent ; palpi, fore femora and posterior edge of the second and fourth abdominal segments yellowish white. Expanse, 18 mm.

Habitat: Massachusetts.

Carmenta nigra *Beuten.*

Carmenta nigra BEUTENMÜLLER, Bull. Am. Mus. Nat. Hist. Vol. VI, 1894, p. 95.

Black ; wings opaque ; hind wings somewhat transparent at the base. Palpi, collar, fore femora, and a narrow band on the second, fourth and sixth segments white. The fore wings also marked with white in the cell and in the area beyond the discal spot. Expanse, 15 mm.

Habitat: Utah.

Carmenta ruficornis *Hy. Edw.*

Carmenta ruficornis HY. EDWARDS, Papilio, Vol. I, 1881, p. 184.
Carmenta minuta HY. EDWARDS, Papilio, Vol. I, 1881, p. 185.

The type of *Carmenta minuta* is in the Tepper Collection in the Agricultural College of Michigan, and was sent to me for examination by Prof. Barrows. It is the male of *Carmenta ruficornis*, the type of which is a female, and not a male, as described by Hy. Edwards.

Habitat: Georgia.

Zenodoxus palmii (*Neumoegen*).

Larunda palmii NEUMOEGEN, Ent. News, Vol. II, 1891, p. 108.

This species was described as a *Larunda* (*Gaëa*), but it would be better placed in the genus *Zenodoxus*, to which it is very closely allied if not identical.

Habitat: Arizona.

Zenodoxus canescens *Hy. Edw.*

Zenodoxus canescens HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.

A very distinct species, differing from all the rest of the known species of *Zenodoxus*. It is wholly ash gray sprinkled with darker gray. The hind wings are transparent, with a gray border. Expanse, 21 mm.

Habitat: Arkansas.

Zenodoxus heucheræ *Hy. Edw.*

Zenodoxus heucheræ HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.
Zenodoxus potentillæ HY. EDWARDS, Papilio, Vol. I, 1881, p. 205.

The types of *Zenodoxus heucheræ*, four in number, in the Edwards Collection, are all males, and the types of *Zenodoxus potentillæ*, also four in number, are all females, and I strongly suspect that the latter is nothing more than the other sex of the former. If not, it is very likely only a variety. It differs from *heucheræ* by having a few reddish scales scattered over the wings and the legs banded with red; in *heucheræ* the scales on the wings and the bands on the legs are yellow. Expanse, 13–18 mm.

Habitat: Lake Tahoe, Sierra Nevada, California.

Zenodoxus maculipes *G. & R.*

Zenodoxus maculipes GROTE & ROBINSON, Trans. Am. Ent. Soc. Vol. II, 1868, p. 184.

Allied to *Z. heucheræ*. Bronzy brown; palpi and collar pale yellowish; abdomen with a yellowish band on the first and fourth segments; hind tibiæ with a yellow ring. Expanse, 20 mm.

Habitat: Texas.

Article VIII.—CATALOGUE OF METEORITES IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY, TO JULY 1, 1896.

By E. O. Hovey.

The Collection of Meteorites in the American Museum of Natural History consists of fifty-five slabs, fragments and complete individuals, representing twenty-six falls and finds. The foundation of the mineralogical department of the Museum was laid in 1874 by the purchase of the collection of S. C. H. Bailey, in which there were a few meteorites. More were acquired with the portion of the Norman Spang Collection of Minerals which was purchased in 1891, and other meteorites have been bought by the Museum from time to time, or have been presented to it by friends. The source from which each specimen came has been indicated in the following catalogue. This publication is made to assist the large number of persons who have become interested in knowing the extent to which the material of various falls and finds has been distributed among collections and the present location of specimens.

AËROSIDERITES. (Iron Meteorites.)

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
$\frac{13}{5}$	1784	**Tejupilco, Toluca Valley, Mexico.** A complete individual, the surface of which has scaled off somewhat. A polished and etched surface shows coarse Widmanstätten figures. (*Bailey Coll.*)	1153.
$\frac{13}{22}$	1784	**Xiquipilco, Toluca Valley, Mexico.** A complete individual of ellipsoidal form, which had been used as a pounder by the natives. (*Spang Coll.*)	564.

AËROSIDERITES.—*Continued.*

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
13/22	1784	**Xiquipilco, Toluca Valley, Mex.**—*Continued.* An obtusely angular specimen, one side of which has been polished and etched, showing coarse Widmanstätten figures. The original surface has been all scaled off. (*Spang Coll.*) [" In 1784 mention was made of the plentiful occurrence of iron in the valley of Toluca. Report of find in Neues Johrb. f. Min. 1856, p. 297." Brit. Mus. Cat. Meteorites, p. 53. 1887.]	251.
13/11	Recognized in 1811	**Elbogen, Bohemia.** A rectangular chiseled and sawed fragment. Shows poor Widmanstätten figures. (*Spang Coll.*) [" Preserved for centuries at the Rathhaus of Elbogen ; its meteoric origin was recognized by Neumann in 1811. Report of find in Gilb. Ann., 1812, Vol. XLII, p. 197." Brit. Mus. Cat. Meteorites, p. 44. 1887.]	6.4
13/16	1840	**Magura, Szlanicza, Arva, Hungary.** A sawed slab showing natural surface on one edge. Etched surface shows small, indistinct markings. (*Spang Coll.*) [" Made known by Haidinger in 1844. Pogg. Ann., 1844, Vol. LXI, p. 675." Brit. Mus. Cat. Meteorites, p. 44. 1887.]	43.
13/14	Fell July 14, 1847	**Braunau, Bohemia.** A sawed, cuneiform piece showing part of an original surface pit. (*Spang Coll.*)	26.4
13/15	1847	**See-Läsgen, Brandenburg, Prussia.** An irregular, chiseled fragment. (*Spang Coll.*) [" Found in draining a field ; several years afterward, in 1847, it was recognized by Glocker as meteoric. Report of find in Pogg. Ann., 1848, Vol. LXXIII, p. 329 ; 1849, Vol. LXXIV, p. 57." Brit. Mus. Cat. Meteorites, p. 43. 1887.]	18.3
13/25	1853	**Tazewell, Claiborne Co., Tenn.** Oblong, rectangular, sawed piece. (*Spang Coll.*) Plowed up on a farm about ten miles west of the village in 1853. Described by C. U. Shepard, Am. Jour. Sci., II, xvii, p. 325. 1854.	52.

AËROSIDERITES.—*Continued.*

Cat. No.	Date of Discovery.	NAME AND DESCRIPTION.	Weight in grams.
12/34	1858–9	**Staunton, Augusta Co., Va.**	
		A polished slab 80 x 75 x 6 mm., one surface etched, showing excellent Widmanstätten figures. (*Spang Coll.*)	217.
		Found in 1858 or 1859 by a colored man named Alf, of the Robert Van Lear plantation, who afterwards threw it away, as he could not sell it for the price he asked (one dollar). After lying neglected for some years it was put with other loose material into a stone wall. Its great weight and irregular shape caused it to fall out of the wall, and it was then used for some time as an anvil. Afterwards it was built into the curbing of a cistern. Here, during the summer of 1877, it was noticed by Mr. M. A. Miller, of Staunton, who obtained it and then disposed of it to Ward and Howell, of Rochester, from whom Mr. Spang procured the slab now in the Museum. Described by J. W. Mallett, Am. Jour. Sci., III, xv, p. 337, 1878, whence the above-given account was taken.	
13/10	1884	**Glorieta Mt., Santa Fé Co., New Mexico.**	
		A complete individual, irregularly meniscus-shaped. Surface pitted and torn. Etched surface shows Widmanstätten figures. (*Purchased from G. F. Kunz.*)	24,154.
		A slab 180 x 123 x 5 to 9 mm. in size. Both sides have been etched and show the typical Widmanstätten figures very perfectly. Three edges show the original surface of the mass. (*Purchased from G. F. Kunz.*)	772.
		Found on a rock on the side of the mountain one mile northeast of the village of Canoncito by a prospector searching for gold. Described by G. F. Kunz, Am. Jour. Sci., III. xxx, p. 235. 1885.	
13/26	1891	**Cañon Diablo, Arizona.**	
		A polished slab 278 x 137 x 7 to 17 mm. in size, an entire section of the mass. Much cohenite is present, frequently inclosing flakes and plates of schreibersite. Three irregularly ellipsoidal nodules are prominent in the mass. They consist of troilite associated with more or less of a relatively soft graphitic (?) substance, and surrounded by a shell of schreiber-	

AËROSIDERITES.—*Continued.*

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
		site, outside of which is a shell of cohenite. The Widmanstätten figures are broad and interrupted, giving the mass an almost granular appearance. (*Purchased from E. E. Howell.*)	2285.
		A complete individual; in shape an irregular, elongated, four-sided pyramid. (*Purchased from E. E. Howell.*)	14.7
		Described by A. E. Foote, Am. Jour. Sci., III, xli, p. 413, 1891, and by O. A. Derby, *Idem*, III, l, p. 101, 1895.	
$\frac{18}{27}$	1893	**El Capitan Mts., New Mexico.**	
		A polished slab 126 x 124 x 4 to 6 mm. in size, showing the original surface of the mass on all edges. The Widmanstätten figures are long and slender, with occasional broad bands. Many of the interspaces show a second, much smaller set of markings. One large nodule of troilite. (*Purchased from E. E. Howell.*)	455.
		Described by E. E. Howell, Am. Jour. Sci., III, l, p. 253. 1895.	
$\frac{18}{18}$	?	**Berg Emir, Siberia.**	
		An irregular chiseled piece showing a torn surface. This locality does not appear in Lippincott's Gazetteer. (*Spang Coll.*)	78.
		Total weight of Aërosiderites........	30,089.8

AËROSIDEROLITES. (Iron-Stone Meteorites.)

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
$\frac{12}{5}$	1847	**Rittersgrün, Erzgebirge, Saxony.**	
		A polished slab in which the stony portion exceeds the metallic. The iron shows delicate Widmanstätten figures. (*Bailey Coll.*)	26.4
		A polished piece in which the iron exceeds the stony matter in amount. (*Bailey Coll.*)	14.2
		[" Reported by A. Breithaupt in 1861. *Zeitsch. d. deutsch. Geol. Gesell.*, Vol. XIII,	

AËROSIDEROLITES.—*Continued.*

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
		p. 148. But according to A. Weisbach it was really found in 1833. '*Der Eisenmeteorit von Rittersgrün in sächsischen Erzgebirge : von A. W.* : Freiberg, 1876.'" Brit. Mus. Cat. Meteorites, p. 57. 1887.]	
$\frac{13}{18}$	1861	**Breitenbach, Erzgebirge, Saxony.**	
		An irregular piece, one side of which has been polished and etched. The particles of iron show Widmanstätten figures. The outer surface has been much rusted. The olivine and other stony matter exceed the iron in amount, and the whole seems to be identical with the specimens from Rittersgrün, No. $\frac{13}{17}$. They are probably parts of the same fall. (*Spang Coll.*)	76.
		Described by N. S. Maskelyne in 1871. *Phil. Trans.*, Vol. CLXI, p. 359. Rittersgrün and Breitenbach are within three English miles of each other, and the aërosiderolites probably fell at the same time. Breithaupt suggests that this was the fall reported to have taken place at Whitsuntide in the year 1164. *Berg. u. hütt. Zeitung*, 1862, Jahrg. XXI, p. 321 : Buchner suggests a fall which took place between 1540 and 1550. *Die Meteoriten*, etc. : *von Otto Buchner* : Leipzig, 1863, p. 124. [Adapted from Brit. Mus. Cat. Meteorites, p. 57. 1887.]	
$\frac{13}{5}$	Fell May 10, 1879.	**Estherville, Emmet Co., Iowa.**	
		Twenty-two complete individuals, ranging in weight from 1.5 g. to 26.2 g. All show the nickel-white, rounded knobs of iron. (*Bailey and Spang Colls.*)	212.6
		An irregular mass, apparently showing none of the original crust. (*Purchased from Miss F. A. M. Hitchcock.*)	138.5
		An irregular mass like the last, but showing a little of the crust. (*Spang Coll.*)	58.
$\frac{13}{8}$	?	**Desert of Atacama, South America.**	
		About half of a spheroidal mass, in which the iron much predominates over the included olivine. Much of the original surface has scaled off, but many of the pits still show. Apparently different from No. $\frac{13}{10}$, and may be the pallasite of Imilac. (*Presented by Mrs. R. L. Stuart.*)	4876.

AËROSIDEROLITES.—*Continued.*

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
13/19	?	**Ensicheim, Elbogen, Bohemia.** A very irregular, spongy iron, which has lost its original inclusions, closely resembling the original Pallas iron. (*Spang Coll.*)	4.5
		There seems to be some confusion about the locality here, since the meteorite from Ensisheim, Alsace, is an aërolite and that from Elbogen, Bohemia, is a holosiderite.	
13/20	?	**Desert of Atacama, South America.** A sharp-pointed, irregular mass of very spongy iron, from which the stony matter has largely decomposed and has fallen out to some extent. Apparently different from No. 13/8. (*Spang Coll.*)	13.3
13/21	?	**Mount Kemis, Siberia.** An irregular, spongy iron, which has lost its original inclusions. (*Spang Coll.*)	31.
		This locality does not appear in the Gazetteer. The iron is like the Pallas iron from Medwedewa, Krasnojarsk, Siberia.	
		Total weight of the Aërosiderolites....	5450.5

AËROLITES. (Stone Meteorites.)

Cat. No.	Date of Discovery.	Name and Description.	Weight in grams.
13/7	Fell May 1, 1860.	**New Concord, Ohio.** A fragment from the interior, preserving none of the crust. This is a gray rock with minute metallic (iron) points scattered thickly through it. (*Bailey Coll.*)	44.5
13/4	Fell June 9, 1866.	**Knyahinya, near Nagy-Berezna, Hungary.** A sub-rectangular individual with grayish-black skin, which has been removed at one spot showing the gray interior with its minute particles of iron. (*Bailey Coll.*)	35.
		A complete, rudely wedge-shaped individual preserving its dull black crust nearly entire. The surface is indented with closely-set small pits. The description makes it probable that this is the correct locality for this stone, though none was given on the Spang label. (*Spang Coll.*)	75.4

AËROLITES.—*Continued.*

Cat. No.	Date of Discovery.	NAME AND DESCRIPTION.	Weight in grams.
$\frac{13}{1}$	Fell Jan. 30, 1868.	**Pultusk, Poland.** A complete, hemispheroidal individual, preserving its thin rusty-black crust. A chipped place shows the light gray interior with its metallic grains. (*Bailey Coll.*)	51.2
$\frac{13}{33}$	Fell May 21, 1871.	**Searsmont, Waldo Co., Maine.** A cuboidal fragment from the interior. Light gray rock with numerous small brown patches. Numerous particles of iron are scattered through the mass, and there is one angular piece (part of a crystal ?) of pyrrhotite. (*Spang Coll.*)	4.2
$\frac{13}{6}$	Fell Feb. 12, 1875.	**Homestead, Iowa Co., Iowa.** A nearly complete individual, roughly pyramidal in shape, showing broad shallow surface pits. The thin, dull-black crust has been broken off in spots, revealing the dark gray interior with minute metallic points scattered through it. This is the fall entered as "West Liberty" in the British Museum catalogue of meteorites. (*Purchased from H. T. Woodman.*)	583.
$\frac{13}{15}$	Fell Feb. 3, 1882.	**Möcz, Transylvania.** A complete, wedge-shaped individual. The comparatively thick, dull-black crust is intersected by a network of fine cracks. The interior is gray with small brown spots in it, and with numerous fine veins and particles of iron scattered through it. (*Spang Coll.*)	165.
		Two smaller complete individuals presenting the same characters. (*Spang Coll.*)	24.7 11.4
		Total weight of Aërolites....................	994.4

Total weight of	Aërosiderites..................	30,089.8
" "	Aërosiderolites................	5,450.5
" "	Aërolites....................	994.4
	Grand Total.............	36,534.7

Article IX.—THE CRANIAL EVOLUTION OF TITANOTHERIUM.

By Henry Fairfield Osborn.

With Plates III and IV, and Fifteen Figures in the Text.

The rapid evolution of the Titanotheres during the deposition of about 180 feet of sediment in the Oligocene White River Beds is one of the striking chapters in mammalian history which is still only partly understood.

The following study of the evolution of the cranium is chiefly an attempt to distinguish the influences of *sex*, of *age* or *growth*, and of *individual variation* from the truly *retrogressive* and *progressive* characters. It is written to this end, but unfortunately we cannot intelligibly treat the morphology of *Titanotherium* without first clearing out the Augean stable of nomenclature. The greater number of the *thirteen* generic and *thirty-one* specific terms which have been proposed are either undefined or undefinable, or are based upon non-specific or non-generic characters.

The materials examined in connection with this study are: Cope's type skulls and jaws now in the American Museum collection; eighteen skulls mostly collected, partly purchased, for the Museum in the expeditions of 1892 and 1894 by Dr. Wortman and Mr. Peterson; the three type skulls in the Harvard University Museum; the few skulls belonging to the U. S. Geological Survey collection[1] in the National Museum at Washington. The author is indebted to Dr. W. D. Matthew for notes upon Marsh's type skulls in the Yale University Museum, also for much valuable assistance.

The illustrations are the work of Rudolph Weber. The majority of the type skulls are shown in the two plates.

[1] These skulls are partly determined by Prof. Marsh. By his direction the cases containing them are kept closed, so that only part of their characters can be observed.

I.—Systematic Introduction.

Historical Notes.

In 1847 (1) Dr. Hiram A. Prout, of St. Louis, described and figured part of a lower jaw containing the true molars of a huge animal which he supposed to be *Palæotherium*. This specimen, as Leidy later remarked in his 'Ancient Fauna of Nebraska' (p. 72), is noteworthy as "the first fossil from the Eocene cemetery of Nebraska, presented to the notice of the world." In 1849 Pomel (2) recognized the distinct generic character of this jaw and termed it *Menodus*, a term which is technically preoccupied and therefore not employable.[1] In 1850 the same jaw was termed *Palæotherium proutii* by Owen, Norwood and Evans (3), without definition. Shortly afterwards Leidy (4) gave the name *P. bairdii* to another specimen. In 1850 Leidy (5) mentioned one other specimen as *P. giganteum*. In 1852 (7) he partially defined the species *T.* (*Rhinocerus*) *americanus* (Pl. XVII, Figs. 1–4). In the same memoir of 1852 Leidy also first used the name *Titanotherium* without definition, but in 1853 he (8) fully described and figured the jaw in the Owen Collection (Anc. Faun. Neb., Pl. XVI, p. 551, Fig. 1) as the type of the new genus *Titanotherium*, mentioning a third species *T. maximum*.

This established the genus. *None of the above species are determinable.* The terms *T. proutii* and *T. americanum* have been variously cited by Marsh, Cope, Scott and Osborn, but are of no specific value whatever; the lower teeth and jaws upon which they are based are incomplete and uncharacteristic; the types have been partly destroyed by fire.[2]

The upper teeth and skull were still unknown. In 1859 Leidy (9) described the palate and superior molars (found by Meek and Hayden in Nebraska, now in the Hall Collection, American Museum of Natural History) as those of a huge *Anoplotherium*.

[1] As Marsh noted in 1873, "The generic name *Titanotherium* Leidy is antedated by *Menodus* Pomel (Bib. Univ. de Geneve, X, p. 75, Jan., 1849). The latter, however, is essentially the same word as *Menodon*, von Meyer, 1838. Hence *Titanotherium* should be retained."

[2] Prout's collection was partly burnt in Burlington, Iowa. A portion of it went to Chicago and was destroyed in the Chicago fire.

TABLE I.—CHRONOLOGICAL LIST OF TERMS.

(1)	Palæotherium	*Prout*	Am. Jour. Sci., 1846, II, p. 288; 1847, p. 248.
(2)	Menodus	*Pomel*	Bib. Univ. de Geneve, X, p. 75, Jan., 1849.
(3)	Palæotherium proutii	*Owen*	Owen, Norwood, Evans., Proc. Acad. Nat. Sci., 1850, p. 66.
(4)	" bairdii	*Leidy*	" " " " " " " p. 122.
(5)	" giganteum	"	Owen's Rep. Geol. Surv. Wisc., Ref. to Pl. XIIB, figs. 3, 4.
(6)	Titanotherium (Rhinocerus) americanus	"	Proc. Acad. Nat. Sci., 1852, p. 2.
(7)	" proutii	"	Anc. Faun. Neb., 1853, p. 76 (Owen's Rep., p. 551).
(8)	" maximum	"	" " " p. 78.
(9)	Anoplotherium	"	Ext. Faun. Dak. and Neb., 1859, p. 206.
(10)	Leidyotherium	*Prout*	Trans. Acad. St. Louis, 1860, p. 699.
(11)	Megacerops coloradensis	*Leidy*	Proc. Acad. Nat. Sci., 1870, p. 1.
(12)	Brontotherium gigas	*Marsh*	Am. Jour. Sci., June, 1873, p. 486.
(13)	Symborodon torvus	*Cope*	Palæon. Bull. No. 15, Aug. 20th, 1873, p. 2.
(14)	" (Miobasileus) ophryas	"	" " " " p. 3.
(15)	Megaceratops acer	"	" " " " p. 4.
(16)	" heloceras	"	" " " " p. 4.
(17)	Symborodon bucco	"	Syn. New Vert. Tert. Col., Oct., 1873, p. 10.
(18)	" altirostris	"	" " " " p. 12.
(19)	" trigonoceras	"	" " " " p. 13.
(20)	Brontotherium ingens	*Marsh*	Am. Jour. Sci., Jan., 1874, p. 85.
(21)	Symborodon hypoceras	*Cope*	Bull. U. S. Geol. Surv. Terr., 1874, p. 491.
(22)	Anisacodon montanus	*Marsh*	Am. Jour. Sci., 1875, p. 246.
(23)	Diconodon *non* Anisacodon	"	" " 1876, p. 339.
(24)	Menodus angustigenis	*Cope*	Ann. Rep. Geol. Surv. Can., Jan., 1896, C., p. 81.
(25)	" tichoceras	*Scott & Osborn*	Bull. Mus. Comp. Zoöl., 1887, August, p. 159.
(26)	" dolichoceras	"	" " " " " p. 160.
(27)	" platyceras	"	" " " " " "
(28)	Brontops robustus	*Marsh*	Am. Jour. Sci., Oct., 1887, p. 326 (Sept. 24th).
(29)	" dispar	"	" " " p. 327.
(30)	Menops varians	"	" " " p. 328.
(31)	Titanops curtus	"	" " " p. 330.
(32)	" elatus	"	" " " p. 330.
(33)	Allops serotinus	"	" " " p. 331.
(34)	Haplacodon angustigenis	*Cope*	Am. Nat., 1889, March, p. 153. (*bis*).
(35)	Menodus selwynianus	"	" " July, 1889, p. 628.
(36)	" syceras	"	" " " " "
(37)	Diploclonus amplus	*Marsh*	Am. Jour. Sci., June 1890, p. 523.
(38)	Teleodus avus	"	" " " p. 524.

In 1860 Prout (10) proposed to make the same specimen the type of a new genus *Leidyotherium*. Leidy soon rectified his mistake, referring this palate to *T. proutii*, but even in his great memoir of 1869 he placed *Titanotherium* in the Anthracotheriidæ. In 1870, still ignorant of the upper skull structure, Leidy (11) described the horns and nasals sent to him from Colorado as *Megacerops coloradensis*, a form which he, in common with Cope and Marsh, believed to be related to the Dinocerata.

Between 1870 and 1873 the explorations of Marsh and Cope in Colorado yielded a series of skulls and limbs, and established these animals definitely as a distinct family of Perissodactyla (see Marsh, Am. Jour. Sci., June, 1873). Marsh (12) founded his first species upon a jaw and dentition, also from Colorado, to which he gave the name *Brontotherium gigas*. He distinguished the genus from Leidy's *Titanotherium* by the presence of but *three* lower premolars. We have seen, however, that Leidy's generic type only contained the four back teeth, P4 to M3, and we now know that the number of lower premolars is subject to individual variation, for some animals have three premolars upon one side and four upon the other side of the jaw. The generic distinction is therefore invalid, while the species *T. gigas*, although founded upon a fine jaw, awaits correlation with a skull before it can be defined. We are indebted to Marsh for the first complete outline of the main characters of the family, in his article of 1873 'On the Structure and Affinities of the Brontotheriidæ." Shortly after *Brontotherium* was proposed, Cope (13) (Aug., 1873) proposed[2] a fourth genus, *Symborodon*, selecting as types "mandibular rami only, which cannot be certainly associated with crania," and distinguishing the genus by the supposed absence of lower incisors and by the presence of but three lower premolars. With his type species *S. torvus* (13) were found three other species, in which he did not at first recognize the Titanothere kinship, namely: *Miobasileus ophryas* (14), *Megaceratops acer* (15), *Megaceratops heloceras* (16). The first named, *M. ophryas*, was established upon a cranium, and proposed as the type of a fifth genus, *Miobasileus*, since abandoned by Cope. In October, 1873,[3]

[1] Am. Jour. Sci. and Arts, 1873, p. 486.
[2] Pal. Bull. No. 15, Proc. Am. Phil. Soc., August 20, 1873, p. 2.
[3] Synopsis of New Vertebrata from the Tertiary of Colorado (*S. ophryas*), Oct., 1873.

Cope referred to *Symborodon* all the preceding as well as the additional species ; (17) *S. bucco*, as the largest type of the genus ; (18) *S. altirostris*, distinguished by the elevated position of the snout and horns ; *S. trigonoceras* (19), distinguished by the short, stout, triquetrous horns.

In January,[1] 1874, Marsh (20) gave the full account of the family above referred to, and proposed the species *Brontotherium ingens* upon a nearly complete skull and jaws. In July, 1874, Cope's 'Report upon the Vertebrate Palæontology of Colorado '[2] contained a full description of the chief characteristics of the family and an analysis of all the species of *Symborodon*, together with the definition of the new species *S. hypoceras*.[3]

All the above specimens, excepting Leidy's original generic type jaws, were found in the Oligocene of Colorado. In 1875[4] Marsh described his collections of 1874 in Dakota and Nebraska and proposed the sixth new genus *Anisacodon* (22), distinguished by three lower premolars and the last upper molar with two cones, the type species *A. montanus* (22) being a skull from Nebraska. In April, 1876, this was re-named *Diconodon*; (23) the principal characters of the family were again discussed, and the types of *B. gigas*, *B. ingens* were figured.[5] In 1886 Cope described the *M. angustigenis* (24) from Canada. Thus the matter rested until August, 1887, when Scott and Osborn[6] reviewed the family and described the collection made for the Harvard University Museum by Garman in Dakota. They revived the term *Menodus* and proposed the new species: *M. tichoceras* (25), *M. dolichoceras* (26), and *M. platyceras* (27), accompanied by a restoration of *M. proutii*. In the meantime Hatcher had brought together for the U. S. Geological Survey a remarkable series from Dakota and Nebraska, which together with skulls from Colorado formed the basis of a further contribution from Marsh.[7] He proposed first the genus *Brontops*, from the type species, *B. robustus*, from northern Nebraska, and the smaller species *B. dispar* from Dakota ; second, the genus *Menops*, from the type, *M. varians*, and the genus *Tita-*

[1] Am. Jour. Sci., Jan., 1874, p. 6.
[2] Bull. U. S. Geol. Surv. Terr., 1873 (publ. 1874), pp. 427–533.
[3] Op. cit., p. 491.
[4] Am. Jour. Sci., March, 1875, p. 245.
[5] Am. Jour. Sci., 1876, p. 335.
[6] Bull. Mus. Comp. Zoöl., Vol. XIII, 1887, p. 157.
[7] Am. Jour. Sci., Oct., 1887, pp. 326–331.

nops from the type skull of *T. curtus* found in Colorado, and a second species *T. elatus*, from Dakota; fourth, the genus *Allops*, from the type skull *A. serotinus* found in Dakota.

In 1889 Cope proposed the genus *Haplacodon* (34) from his Canadian Survey species, *M. angustigenis*,[1] and added the two additional species *M. selwynianus* (35) and *M. syceras* (36). His latest additions are found in his report[2] from the Oligocene of the Cypress Hills, Canada, in which he further characterizes the three new species above referred to.

The latest genus to be added to the long series is *Teleodus* (37), characterized by Marsh[3] as having *three* lower incisors, and believed by Hatcher to come from the lowest beds, also to possess a trapezium.

It is obvious that the only method of clearing up this heterogeneous list is first to establish certain laws of cranial development, and second, to apply these laws to the distinction of the genera and species in chronological order. Examined in this way, the vast array of genera and species are resolved into one or possibly two genera, and about fourteen definable species.

II.—Principles of Cranial and Dental Evolution.

The main characters hitherto used in definition by Marsh and Cope, Scott and Osborn, are :

A. Number of incisors and of premolars. (Cope, Marsh.)

B. Development of a cingulum upon the premolars. (Cope, Marsh.)

C. Presence of a second cone upon last superior molar. (Marsh.)

D. Length and shape of nasals. (Cope, Marsh, Scott, Osborn.)

E. Length and shape of horns. (Cope, Marsh, Scott, Osborn.)

F. Presence or absence of a trapezium. (Hatcher.)

[1] Am. Nat., 1889, p. 628.
[2] Contr. to Canadian Palæontology, Vol. III, p. 9.
[3] Am. Jour. Sci., June, 1890, p. 524.

The principles of cranial evolution which put these characters to the test and determine which are valid and which invalid, may be considered under ten heads: 1. General increase of size. 2. Dental series as a whole. 3. Horns. 4. Nasals. 5. Zygomatic arches. 6. Auditory meatus. 7. Cingula. 8. Incisors. 9. Canines. 10. Hypocone.

1. *General Development in Ascending Geological Levels.*

PROGRESSIVE.	RETROGRESSIVE.
1. General increase in size of skull and skeleton.	2. Dental series relatively arrested or retrogressive in development.
3. Horns elongating in males. *a.* Shifting forwards to absorb nasals. *b.* Long axis altering from antero-posterior to transverse plane. *c.* Acquiring a transverse connecting crest, uniting them at the base.	4. Nasals degenerating in both sexes to reduced knobs. No sexual differences apparent. 9. Trapezium disappearing at an early period.
5. Zygomatic arches spreading.	8. Incisors becoming variable at an early period, especially in females.
6. Post-glenoid and post-tympanic processes uniting.	7. Premolar cingula reduced in latest stages.
6*a*. Occiput broadening and becoming more robust; superior border becoming deeply concave.	7*a*. First lower premolar becoming variable.

12. Third trochanter developing.[1]

2. *Growth and Age Characters common to both Sexes and all Geological Levels.*

1. Increasing rugosity of the skull, arches, horns and nasals.

8. Loss of variable and vestigial teeth, incisors and premolars in old age.

11. Anterior caudal[2] uniting with sacrum to form four sacrals.

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[1] Teste Hatcher, Am. Nat., March, 1893, p. 216.

[2] Teste Hatcher, Am. Nat., March, 1893, p. 217.

Table II.—Measurements of Skulls and Teeth.

	Catalogue Number of Specimen.	Length of Skull.		Width across Zygomatic arches.	Length of Molar-Premolar Series.		Occiput.[1]		Horns.[2]		Nasals.[3]
		Condyle to tip of Premax.	Occiput to tip of Nasals.		p^1–m^3.	p^{1-4}	Height.	Breadth	Length.	Spread.	Free Length.
T. heloceras	6360	.687	.652	.393	.287	...	.175	.169	.126	.280	
T. trigonoceras, Type	6355	....	.765	.485	....	....	.172	.266	.145	.348	.141
T. trigonoceras	6356	...	...	..	.354	.130	..	....	.150	.358	.130
T. trigonoceras	501	.675	.705	.452	.314	.125	.225	.278	.130	.280	.100
T. trigonoceras	1445	.680	.680	.470	.345	.135	.222	.276	.111	.280	.100
T. ingens, Type	....	....	.915[4]	.558	.428	.162	....	....	....	.507	
T. ingens ♂	505	.805	.780	.546	.398	.150	.247	.325	.192	.494	.126
T. ingens ♂	1066	.770	.830	.550	.365	.135	.225	.335	.183	.435	.122
T. ingens ♀	1067	.730	.820	.440	.355	.140	.265	.260	.214	.480	.127
T. ingens ♀	506	.805	.770	....	.410	.151	....	....	.175	...	.135
T. (bucco) torvum	6345	.665	.813	.660	.291	....	.225	.330	?.210	?.361	.090
T. (bucco) torvum	6346	...	....	.670	....	....	.300	.325			
T. robustum ♂	1083	.758	....	.600	.365	.141	....	....	.150	.355	.090
T. robustum ? ♂	1069	.833	.880	.645	.380	.145	.390	.170	.130	.324	.096
T. robustum	1082	.767	.835	.652	.355	.132	.235	.355	.178	.378	?.085
T. robustum ♀	518	.825	.835	.557	.408	.165	.240	.356	.110	.300	.075
T. torvum (robustum)	1081	.707	.767	.610	.367	.139	.250	.320	.231	.307	.066
T. dolichoceras	520	.720	.850	.565	.330	.132	.215	.345	.145[1]	.422[1]	.068
T. elatum ♂	492	.880	.930	.737	.362	.125	.285	.440	.361	.566	.100
T. elatum ♂	1070	....	....	....	...	.132	....	....	.240	.418	.090
T. elatum ♀	1005	.690	.678	.540	.346	.135	.203	.292	.142	.287	.047
T. elatum ♀	1006	.720	.740	.490	.335	.126	.265	.300	.155	.290	.073
T. amplum (elatum) ♀	1008	.735	.781	.495	{.365 .340}	....	....	....	.233	.340	.040
T. acer ♂, Type	6348	....	.680	....	....	....	.235	....	.290	.350	.061
T. (altirostris) acer ♀	6350	.634	.645	....	?.330	..	.245	....	?.141		
T. acer ♀	6349	.635	.655	....	.335	.130	.235	.185	.178	.290	.050
T. ramosum ♂, Type	1447	.742	.820	.774	.360	.181	.250	.400	.399	.635	.049
T. platyceras ♂	1448	.730	.858	.815	.342	.123	.280	.455	.433	.620	.019

[1] In several cases these measurements are approximate, owing to crushing.
[2] This measurement is taken down the outer side of the horn to the anterior nares.
[3] This is the free portion of the nasals as seen in profile.
[4] Lineal measurement taken from condyle to tips of nasals.

3. *Sexual Characters, common in all Species, especially in the Higher Geological Levels.*

MALE.	FEMALE.
1. Skulls of greater dimensions.	1. Skulls of smaller size.
3. Horns, especially in upper beds, very long and powerful.	3. Horns shorter, often imperfectly ossified at the tips.
3*a*. Transverse connecting crest very prominent in higher levels.	3*a*. Transverse crest somewhat less prominent.
5. Zygomatic arches widely extended into buccal plates.	5. Zygomatic arches less widely expanded.
1. Occiput with stout lateral pillars and broad rugose upper border (in upper beds).	1. Occiput less robust.
9. Canines robust.	9. Canines smaller, pointed.
8. Incisors larger and more constant.	8. Incisors more variable, smaller.

Hatcher[1] has placed 'delicate nasals' and a 'feebler internal cingulum' upon the premolars among the female characteristics. Our observations do not confirm this; these structures are apparently independent of sex.

4. *Individual variations observed in members of the same sex and species.*

8. Incisors sometimes constant, sometimes entirely wanting or unequal in number upon opposite sides of the skull, varying from 2 to 1 to 0.
7. Premolar 1 variable, sometimes present upon one side and wanting upon the other side of the jaw.
10. Second internal cone upon last superior molar inconstant in members of the same species.
7. Internal cingulum upon premolars variable.

A comparison of the figures upon Plates III and IV shows the rapid increase in size. The Titanothere skull development in general is marked (*a*) by the forward movement of the orbit; (*b*) the great backward elongation of the skull and temporal fossæ; (*c*) in the occiput the deep excavation of the superior border, the development of lateral pillars, and of the superior rugose crest; (*d*) closure of the external auditory meatus inferiorly.

[1] Am. Nat., March, 1893, p. 216.

5. *Influences of Age, Sex, Growth and Variability.*

1°. General laws of growth.—In the accompanying Table II the species are arranged approximately in the order of evolution, taking *T. heloceras* as the least specialized and *T. platyceras* as the most specialized types.

The skull gains only 10 or 20 centimeters in *length*, while it doubles in *width*, gaining 400 centimeters.

The premolar-molar series rapidly increases in length, and then as rapidly diminishes, so that the grinding area is no larger in the very large animals (*T. platyceras*) of the upper beds than in the small animals (*T. trigonoceras*) of the lower beds.

The occiput gains about 10 centimeters in height and nearly 30 in breadth.

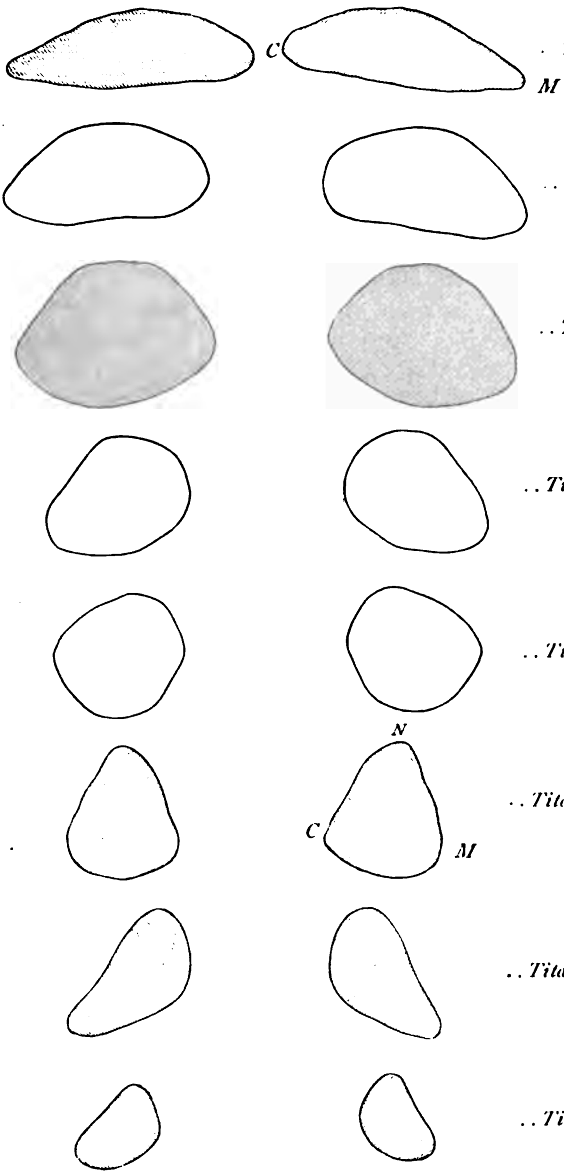
The horns increase to three or four times their original length while the nasals diminish to one-sixth their original length.

2°. Arrested growth of the teeth.—1 & 2. The general increase in the size of the skull and body is not accompanied by a corresponding increase in the dental series. Table II shows that the premolar-molar series reach their maximum in the characteristic species of the middle beds, namely, *T. ingens*, and then actually decline, so that in the enormous animals of the highest beds the dental series has relatively less volume than in the comparatively small creatures of the lower beds. This arrested tooth development may have been a factor in extinction. An exactly analogous fact is observed in the Dinocerata.

3°. Horns. The whole skull structure is mainly secondary to the horns. The successive stages in the form and position of the horns are therefore highly characteristic.

1st Stage.—In *Telmatotherium*[1] and *Diplacodon*[2] they arise at the junction of the fronto-nasal suture, slightly in front of the orbits, overhanging the sides of the face. The primitive horn section is therefore an *antero-posterior oval*, and the longest diameter of all of the earliest horn types is parallel with the long axis

[1] Osborn, 'Fossil Mammals of the Uinta Basin.' Bull. Am. Mus. Nat. Hist., 1895. p. 91.
[2] Hatcher 'On a New Species of Diplacodon,' Am. Nat., 1895, Pl. XXXVII.



. *Titanotherium platyceras.* (No. 1448.)

. . *Titanotherium ramosum.* (No. 1447.)

. . *Titanotherium elatum.* (No. 492.)

. . *Titanotherium robustum.* (No. 1083.)

. . *Titanotherium bucco.* (No. 6345.)

. . *Titanotherium trigonoceras.* (No. 6355.)

. . *Titanotherium trigonoceras.* (No. 501.)

. . *Titanotherium heloceras.* (No. 6360.)

DIAGRAM I.—Horn sections taken just above the base, showing the development from an antero-posterior to a transverse axis. *N*, line connecting with nasals. *M*, line descending to malars. *C*, line entering connecting crest. The anterior face of the horns is above.

of the skull; the anterior edge of the oval extends into the sides of the nasals *N*, the posterior edge dips back to the malars *M*. At the close of this stage the horns acquire a *circular section*.

2d Stage.—A low 'connecting crest' arises between the bases of the horns and gives them a *trilateral section* consisting of an antero-median face, a postero-median face, and an antero-inferior face. Thus all middle horn types are triangular, with an internal angle *C*.

3d Stage.—The horns gradually shift forwards until they directly overhang the anterior nares, and finally the symphysis. They thus *absorb* the nasals and lose their base of support upon the greatly abbreviated maxillaries. Thus disappears the nasal angle *N*; also the antero-inferior or maxillary face, and the horns acquire a *transverse oval* section.

4th Stage.—While the horns flatten, the web, or '*connecting crest*,' between their bases, increases until the horns consist of two recurved plates connected by a broad median crest. This is the final stage, consisting of a "*disc section*."

There is thus a total change in form and position.

The ontogeny of the horns recapitulates the phylogeny more or less closely in the lower beds only.

Both Marsh and Hatcher have remarked that females are distinguished by smaller horns. But Marsh has not applied this principle in his definitions. The sexual distinctions are as follows:

Female Horns.—In *female* Titanotheres the horns exhibit an *arrested stage of male development*. This is most clearly demonstrated in the comparison of three female skulls (Nos. 1005, 1006, 1008) in the American Museum Collection, with two male skulls (Nos. 492, 1070) of the species *T. elatum*. (See Figs. 9, 10, 11.) In the females the horns are often imperfectly ossified at the tips, sometimes pointed. As the horns evolve in the higher levels the differences between the sexes become more marked, for we observe less wide contrasts in skulls found in the lower beds. As seen in *T. acer*, *T. trigonoceras* and *T. ingens*, the 'connecting crest' is more constant and more pronounced in males than in females.

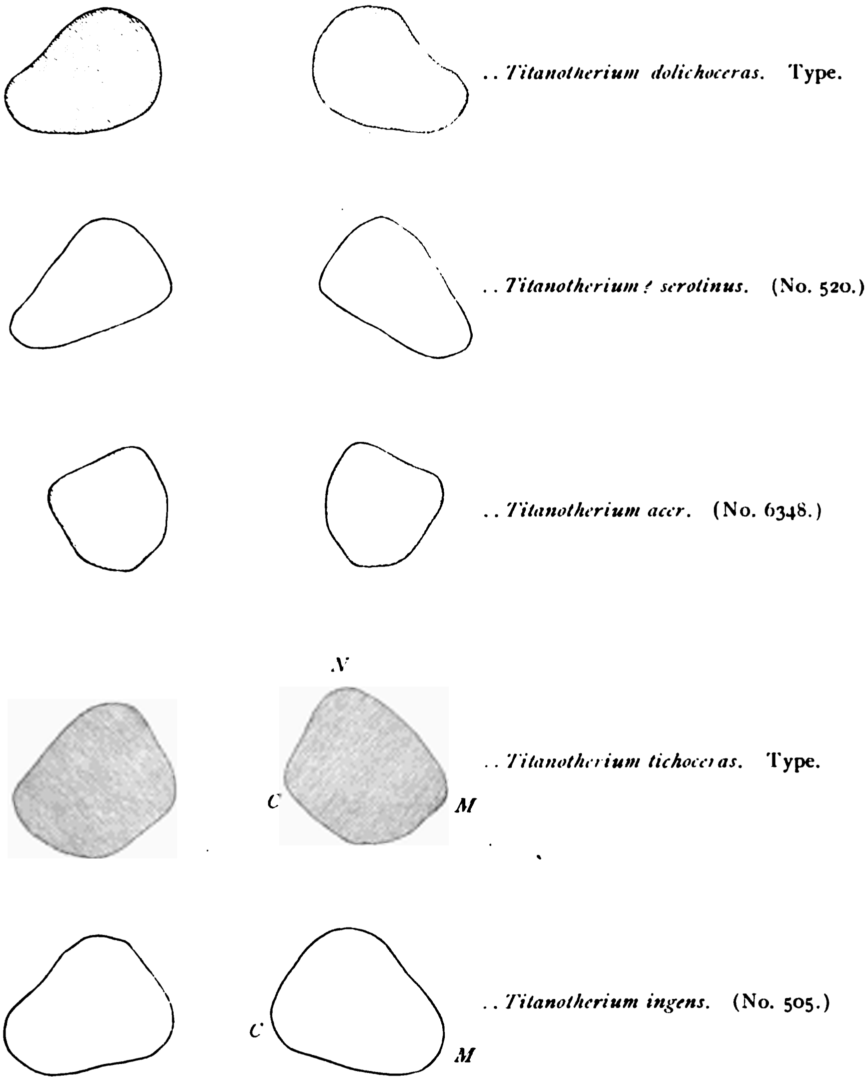


DIAGRAM II.—Horn section taken in the same manner as Diagram I.

Again, among the skulls referred to *T. ingens* (505, 1066, 1067), three have very stout triangular horns, a fourth (506), although a very large animal, has more slender horns, rounder in section, with very slender canines. This is believed to be a female. Similar differences are observed in specimens of *T. trigonoceras.*

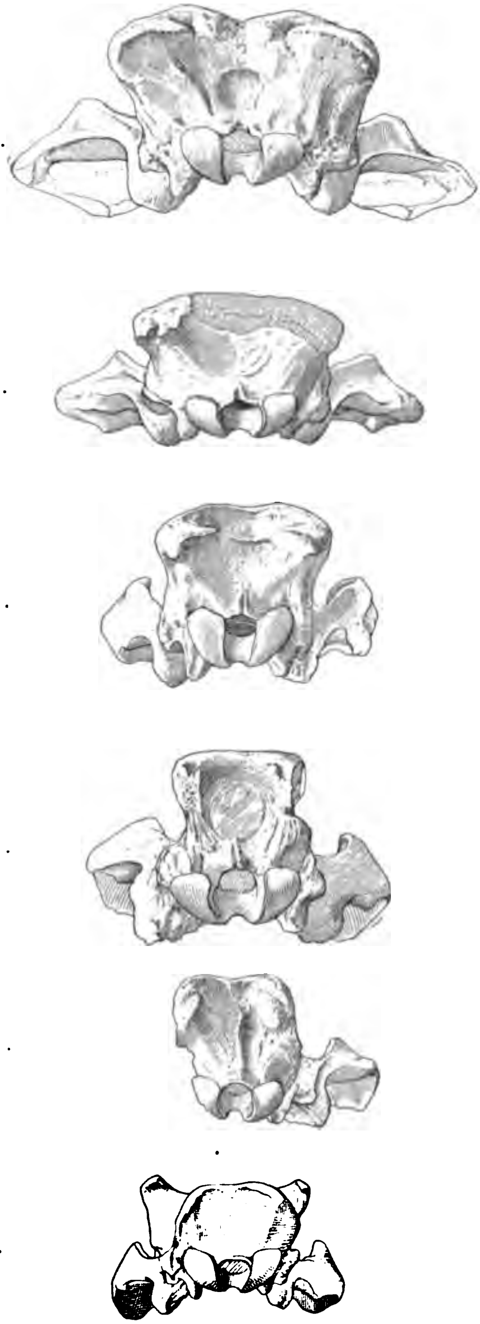
Individual Variations.—The appearance of the horns is greatly affected by the stages of growth and by the crushing. There are two cases of *branching* in this collection, a feature considered by Marsh a generic character in his type of *T.* (*Diploclonus*) *amplus.* One case is in the horns of a female of *T. elatum* (1008), another is in an undetermined skull (1081). This character is apparently an individual variation.

4°. NASALS.—The hypertrophy of horns and compensating atrophy of nasals was pointed out by the writer in 1887. It now appears more accurate to state that the horns practically shift forward to the tips of the nasals.

The length and form of the nasals is a characteristic feature of progressive development, and is very slightly if at all subject to sexual variation as believed by Hatcher[1]. In the primitive condition[2] (*Diplacodon*) the nasals are long, and distally broad and truncate. In *T. coloradense* Leidy they taper and are recurved distally. In the *T. trigonoceras* and *T. ingens* skulls they are broad, rugose and often cleft distally. In progressive development they are rapidly reduced in length and tapered so that they finally become short-pointed knobs.

5°. ZYGOMATIC ARCHES.—There is considerable but not absolutely conclusive evidence that the very robust widely spreading zygomatic arches of the latest species are *male* characteristics. In the *T. elatum* series all the skulls with feeble or imperfect horns and small canines have moderately expanded arches, while the old male (No. 492) has enormous cheek bones. In the *T. ingens* series the same difference is observed in a less marked degree. If this character is actually sexual, it is one in which (as in the horns) the males progressively diverged from the females in the evolution of the skull.

[1] Am. Nat., March, 1893, p. 216.
[2] Hatcher, *op. cit.*, Pl. XXXVII.



Titanotherium elatum ....
(No. 492.)

Titanotherium bucco .. ..
(No. 6345.)

Titanotherium ingens ♀ ....
(No. 1067.)

Titanotherium coloradense ....
(Harv. Univ. Mus.)

Titanotherium acer ....
(No. 6348.)

Titanotherium heloceras ....
(No. 6360.)

Fig. 1. Exhibiting the evolution of the occiput, the lateral pillars, and incurving of the superior border. One-twelfth natural size.

6°. AUDITORY MEATUS.—The union of the post-glenoid and post-tympanic processes parallels that which we observe in the Rhinoceroses. In the *T. heloceras* skull the external auditory meatus is widely open below. In the *T. platyceras* skull it is reduced to a small foramen enclosed by a solid wall of bone below.

7°. CINGULUM.—The cingula are, upon the whole, retrogressive. They reach their greatest development in *T. ingens*, and then decline.

Our materials do not support Hatcher's[1] supposition that strong cingula are characteristic of male skulls, but prove that the development of the *cingulum is irrespective of sex, partly a matter of individual variation, chiefly of robust dentition.*

It follows that Cope[2] is in error in relying upon the cingulum to divide the Titanotheres into two parallel groups.

Variability.—In two closely similar skulls (Nos. 501, 1445) the internal premolar cingulum is strongly developed, while the external cingulum is feeble in the one (1445) and strong in the other (501).

Independent of Sex.—In the female skull of *T. ingens* (No. 506), the cingula are quite as strongly marked as in the male skulls (Nos. 505, 1066, 1067). In the female skulls of *T. elatum* (Nos. 1005, 1006) the cingulum is as strong or stronger than in the male skulls (Nos. 492, 1070).

Associated with robust dentition.—The only forms in which sharply-defined internal and external cingula upon both upper and lower premolars seem to be characteristic, are the type skull and the American Museum skulls of *T. trigonoceras* and *T. ingens.* As shown by the measurements, this species is characterized by a very robust dentition.

Retrogression.—A comparison of all the earlier with the later types shows that the cingulum reaches its maximum with the species or the middle beds, and then declines. It is variable in *T. robustum* and almost obsolete in *T. acer* and *T. platyceras.*

[1] Am. Nat., March, 1893, p. 216.
[2] Contr. to Canadian Palæontology, Vol. III, 1891, p. 9.

8°. INCISORS.—Individual variability here is very marked, but there seem to be certain underlying principles, such as the following :

Persistence.—So far as the American Museum material is concerned, there is no evidence that the incisors are positively retrogressive, as commonly stated by Hatcher and others, since three heavily horned male skulls of *T. platyceras* and of *T. elatum*, from the topmost strata, present two pairs of full-sized incisors. Marsh[1] also implies that his long-horned specimens (*Titanops*) have two upper incisors.

On the other hand, one of the most primitive skulls (No. 501) of *T. coloradense* presents but one incisor upon each side, and all the skulls in the middle beds (*T. ingens*) of our collection exhibit no incisors at all.

Sex.—Of the supposed females of *T. elatum*, one (1005) has no upper incisors, one (1006) has reduced vestiges of the lateral pair, two (1008, 520) have the outer pair well developed. Marsh's type is said to have two upper incisors. It would appear from this that in this species at least the incisors are more variable and reduced in females than in males.

This evidence is offset by the fact that in all the five, *T. trigonoceras*, *T. ingens* skulls the incisors are vestigial or wanting without distinction of sex. Marsh figures two incisors in dotted outlines, but his type of *T. ingens* entirely lacks the premaxillaries, and therefore gives no evidence. It would appear, however, that in *T. trigonoceras* the incisors are vestigial or wanting in both sexes and in both jaws.

9°. CANINES.—We here derive characters both of sexual and of specific value.

Sex.—The shape of the canines is the same in both sexes, but the male tusks are much more powerful than the female. This is especially marked in the male *T. ingens* (No. 505), in which the tusks are 62 mm. long by 34 mm. diameter at the cingulum, while in the female (No. 506) the canines measure only 40 x 21 mm.

It is also well shown in *T. elatum* in which the female tusks are also two-thirds the size of the male tusks, as observed in a com-

[1] Am. Jour. Sci., Oct., 1887.

parison of five skulls. In the latest types of males the canines are powerful but obtuse.

10°. Second internal cone of last upper molar.—Individual variability here reaches its maximum. This cone, which is well known to occur in the *Palæosyopinæ* of the Bridger, is apparently neither a specific nor progressive character in *Titanotherium*. It is found in all stages of independence from the cingulum in the oldest as well as in the most recent types. It certainly varies within the limits of a single species and sex.

6. *General Conclusions.*

The net result of this examination is that the characters upon which the genera *Symborodon*, *Diconodon*, *Brontops*, *Titanops*, *Allops*, *Haplacodon* and *Diploclonus* are founded, are either marks of sex, age or individual variability, and that these names have no standing whatever. *Teleodus* may prove to be a distinct form, but has not yet been separated generically from *Diplacodon*.

II.—Revision and Definition of Species.

For Dates, see Table I.

Menodus *Pomel.*

Preoccupied by *Menodon*, von Meyer.

3. Titanotherium proutii *Leidy.*

Indeterminate species.

4. Titanotherium bairdii *Leidy.*

Indeterminate species.

5. Titanotherium giganteum *Leidy.*

Indeterminate species.

6. Titanotherium americanum *Leidy.*

Indeterminate species.

8. Titanotherium maximum *Leidy.*

Indeterminate species.

11. Titanotherium coloradense *Leidy.*

PLATE III.

Megacerops coloradensis LEIDY. (Type of genus *Megacerops.*)

Type Loc —Colorado. Level unknown.

Type.—Fractured horns and nasals. Coll. Acad. Nat. Sciences, Phila.

Spec. Char. (of Type).—*Horns* of medium length; section antero-posterior oval or slightly trihedral at base, rounded at summit; directed upwards and outwards; no transverse crest. *Nasals* long, tapering somewhat, decurved and notched at extremity.

The full characters of this species are not certainly known. In the Harvard University Museum is a complete skull in which the corresponding parts are closely but not exactly similar in form and measurement to Leidy's type. This skull,[1] apparently female, exhibits the following characters:

Cranium long and narrow; occiput elevated and slender, narrow, with superior border not incurved; zygomatic arches expanding slightly; external cingulum feeble upon P^{1-3}, strong upon P^4, post-glenoid and post-tympanic processes not quite in contact; one superior incisor.

A closely related, if not identical form, is the Canadian Survey specimen, referred to *T. americanum* by Cope.[2]

12. Titanotherium gigas (*Marsh*).

Brontotherium gigas MARSH. (Type of genus *Brontotherium.*)

Type Loc.—Colorado. Level not ascertained.

Type.—" Lower jaws and entire molar series complete." Yale Univ. Mus.

This species and genus were defined by the presence of *two* lower incisors, while the lower jaw exhibits but *three* premolars on each side. It has an evenly-arched lower border and shallow chin. It remains *indeterminate* until the skull characters become known.

[1] It has unfortunately been injured since it was described and figured by Scott and Osborn, Bull. Mus. Comp. Zoöl., 1887, p. 158.
[2] Contr. Can. Pal., Vol. III, p. 10, Pl. vi, fig. 1.

13. Titanotherium torvum (Cope).

PLATE III.

Symborodon torvus COPE. (Type of genus *Symborodon*.)

SYN. *Symborodon bucco* COPE.

Type Loc.—Colorado. Level not ascertained.

Type.—Complete lower jaws. Coll Am. Mus. Nat. Hist., No. 6365.

Spec. Char.—*Horns* short, above narial opening, ? sub-circular in section; directed forwards, upwards and outwards; no connecting crest. *Nasals* of medium length, notched distally. Zygomatic arches widely projecting with a rounded outer section, slightly flattened vertically. Occiput low, deeply excavated, heavy outer pillars. External premolar cingula reduced or wanting. Dentition : $\frac{2}{0}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$.

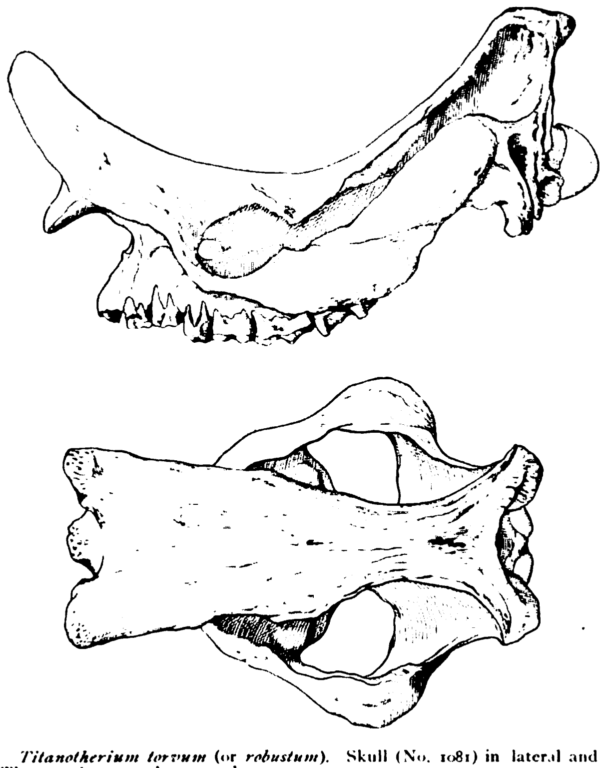


Fig. 2. *Titanotherium torvum* (or *robustum*). Skull (No. 1081) in lateral and superior views. The *nasals* are partly restored.

The type jaw entirely lacks the lower incisors and presents only three premolars upon each side. The premolars exhibit incomplete external cingula. As observed by Cope, it agrees precisely with the lower jaw of Cope's type of *Symborodon bucco* (No. 6345, Am. Mus., Cope Coll.), and it is by combining these two types that we obtain the specific characters given above.

Unfortunately in Cope's type of *S. bucco*, from which all the skull characters in the above definition are derived, the horns and nasals, although present, are very imperfectly preserved. This

Fig. 3. *Titanotherium torvum* (or *robustum*). Skull (No. 1081) in front view, exhibiting the *branching* of the horns.

makes it impossible to exactly define this species, or determine its sex. The premaxillæ have been lost, so that it is impossible to verify Cope's statement that there are *two* upper incisors.

Cope's associated type of *S. bucco* (Am. Mus., Cope Coll., No. 6346) is the posterior half of a skull with very powerful, rounded, zygomatic arches. It is apparently a male skull, but does not certainly belong to this species.

The most closely related form is Marsh's species *T.* (*Brontops*) *robustum*. It may subsequently prove to be identical. Cope's associated type of *S. bucco* has the same zygomatic arch-section.

14. Titanotherium ophryas (*Cope*).

Symborodon ophryas Cope. (Type of genus *Miobasileus* Cope.)

Type Loc.—Colorado. Level not determined.

Type.—A fragmentary skull, including nasals and horns.

This is practically a *nomen nudum*. The original skull was broken up in removal and transportation, and the original description does not enable us to distinguish the species.

15. Titanotherium acer (*Cope*).

PLATE IV.

Symborodon acer COPE.
SYN. *S. altirostris* COPE. Type, a female skull of *T. acer.*
" ? *Menodus syceras* COPE.

Type Loc.—Colorado. Level undetermined.

Type.—A male skull lacking the teeth and zygomatic arches. (Am. Mus., Cope Coll., No. 6348.)

Spec. Char.—*Horns* long, rising on stout maxillary column overhanging narial opening, sub-oval, antero-posterior section of base greater than transverse. ♂ Horns very long, recurved, flattened at summit, with a low connecting crest, and a slight external ridge. ♀ Horns shorter, directed forwards. *Nasals* very short, tapering to extremities. Occiput high and narrow, superior border not incurved. ♀ Zygomatic arch rather slender, slightly spreading. Premolar cingula reduced externally. ♀ Superior incisors vestigial. Lower jaws unknown.

This small species is sharply characterized by the antero-posterior oval form of the horns, the long narrow cranium, and the high slender occiput. The female skull (type of *S. altirostris* Cope, No. 6350, Am. Mus.) has shorter horns but precisely similar skull and nasal dimensions and characters. As in some other female skulls, the connecting crest between the horns is wholly wanting, and the superior incisors have dropped out, although apparently present in the young condition.

Fig. 3*A*. Skull of female *T.* (*altirostris*) *acer*. (No. 6350), front view.

A second female skull (No. 6349, Am. Mus., Cope Coll.) has horns somewhat flattened posteriorly, but is otherwise similar.

The type of *T. syceras* Cope[1] from the Swift Current Creek, Canada, exhibits horns and nasals of the same character as the above.

As in all the long-horned species examined by the writer, the external premolar cingula are nearly obsolete.

[1] Contr. Can. Pal., III, Pl. viii.

16. Titanotherium heloceras (*Cope*).

PLATE III.

Symborodon heloceras COPE.

Type Loc.—Colorado. Level unknown.

Type.—A skull with teeth, nasals and part of frontals wanting. (No. 6360, Am. Mus., Cope Coll.)

Spec. Char.—*Horns* rudimentary, divergent. Post-glenoid and post-tympanic processes not in contact. *Occiput* broad and low. Zygomatic arches slender, vertical, not spreading.

This animal is very imperfectly known. From the open condition of the external auditory meatus it is evidently a very primitive type. The rudimentary condition of the horns is possibly a female character. The type is of advanced age.

This animal probably had moderately broad, elongate nasals, and three upper and lower incisors. Unfortunately these parts are wanting in the type.

17. Titanotherium bucco (*Cope*).

PLATE III.

Symborodon bucco COPE.

Type Loc.—Colorado. Level unknown.

Type.—A complete skull and lower jaws. Sex unknown. (No. 6345, Am. Mus., Cope Coll.)

This species is a synonym of *T.* (*Symborodon*) *torvum* Cope, as determined by the almost identical characters and measurements of the lower jaws.

18. Titanotherium altirostris (*Cope*).

Symborodon altirostris COPE.

Type Loc.—Colorado. Level unknown.

Type.—A female skull. (No. 6350, Am. Mus., Cope Coll.)

The type of this species is a female skull of the species *T. acer* Cope, described above.

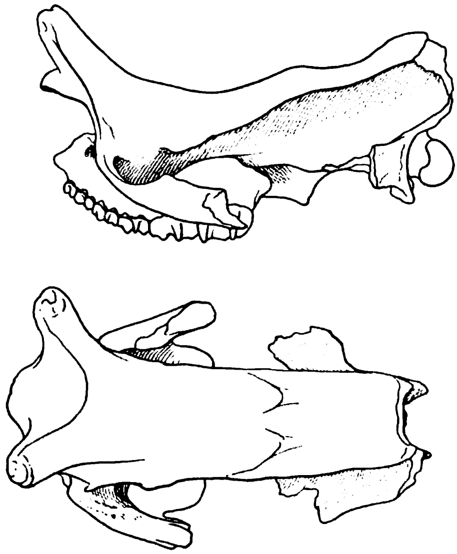


Fig. 4. Skull of female *T.* (*altirostris*) *acer*, side and top views (No. 6350). One-twelfth natural size.

19. Titanotherium trigonoceras (*Cope*).

PLATE III.

Symborodon trigonoceras COPE.

Type Loc.—Colorado. Level undetermined.

Type.—A cranium lacking the teeth. (No. 6355, Am. Mus., Cope Coll.)

Spec. Char.—*Horns* short, rising upon maxillaries, partly over the orbits ; ♂ sub-triangular in section at base, directed outwards and upwards, in latest types united by low connecting crest ; ♀ more slender and rounded superiorly, no connecting crest. *Nasals* very long, overhanging symphysis, square or broadening distally, notched. Zygomatic arch vertically deep in section, with an inferior lateral bulge in front of glenoid facet. Occiput low and broad, incurved upon superior border ; ♂ robust lateral pillars. Incisors vestigial. Canines moderately large. Premolars with external and internal cingula. Dentition : $\frac{3-0}{}$, $\frac{1}{}$, $\frac{4}{}$, $\frac{3}{}$. Lower jaw unknown.

The type skull lacks most of the teeth. The associated type (Am. Mus., Cope Coll., No. 6356) exhibit four vestigial incisors. As observed by Cope,[1] it is of smaller size, substantially of the

[1] Bull. U. S. Geol. Surv. Terrs., 1873, p. 490. (Pub. 1874.)

same proportions and characters as *T.* (*Brontotherium*) *ingens* Marsh, but the latter is a distinct species. The last upper molar has quite a distinct second internal cone. The 'connecting crest' is feebly developed.

Fig. 5. *Titanotherium trigonoceras.* Skull (No. 1445) and lower jaws (No 516), found in the lower beds. One-tenth natural size.

Two fine skulls (Nos. 501, 1445) in the American Museum Collection are provisionally referred to this species, although the horns are less distinctly triangular, presenting a transition between *T. coloradense* and *T. trigonoceras.*

In No. 501 there are two upper incisors and no second internal cone upon the last upper molar. In the closely similar No. 1445 there are no evidences of upper incisors, and there is a decided second internal cone upon the last upper molar.

In other respects the two skulls agree quite closely. The 'connecting crest' is feebly developed, thus the horn section is a longitudinal oval with a triquetrous base. The nasals are long and expand somewhat distally. The occiputs are robust and somewhat indented superiorly. The post-glenoid and post-tympanic processes are in slight contact.

This species, characteristic of the lower beds and lower portion of the middle beds, is sharply defined. It is probably ancestral to *T. ingens* Marsh, which is confined to the middle beds and may be distinguished by the long pointed canines and very large size.

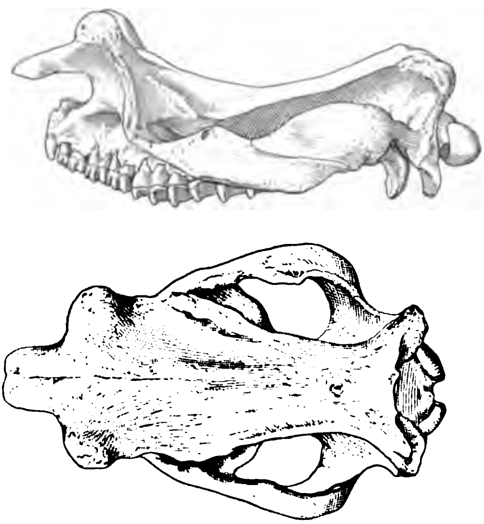


Fig. 6. *Titanotherium trigonoceras.* Skull (No. 1445), superior view. Skull (No. 501), in side view. One-twelfth natural size.

20. Titanotherium ingens (*Marsh*).

PLATE III.

Brontotherium ingens MARSH.

Type Loc.—

Type.—A complete male skull. Yale Univ. Mus.

Spec. Char.—*Horns* short, rising upon maxillaries partly above orbits; ♂ sub-triangular in section, with 'connecting crest'; directed strongly upwards and outwards. ♀ more slender, elongate oval in form, no 'connecting crest.' Nasals in both sexes, long, expanding and rugose distally, notched. Zygomatic arch with a deep vertical section, and a decided bulge just in front of glenoid facet, strongest in ♂ skulls. Incisors ? 2–0, vestigial or wanting. Canines very long and pointed, extending below level of premolars, ♂ robust, ♀ slender. Premolars and molars with robust external and internal cingula. Second internal cone of last upper molar variable, sometimes strongly distinct. Dentition: $\frac{2}{2}-\frac{0}{0}$, $\frac{1}{1}$, $\frac{4}{4}$, $\frac{3}{3}$.

The four fine skulls (Nos. 505, 506, 1066, 1067) in the American Museum Collection are referred to this species, although in all of them *the upper incisors are vestigial or wanting*. Marsh assigns two upper incisors to his type, but the premaxillaries are apparently wanting.

Two of these skulls (Nos. 506, 1067) are apparently females, the horns are more slender and pointed; the upper and lower canines are long but less robust. Neither skull has any trace of upper or lower incisors.

Of the supposed male skulls No. 505 agrees exactly with Marsh's type specimen; the outer upper incisor is represented by one small alveolus, the tooth has disappeared. The other skull, No. 1066, has *two* vestigial alveoli. It is apparent that in this species, so closely related to *T. trigonoceras*, the *upper incisors are variable, vestigial or wanting.*

These two male skulls have strong canines, more robust zygomatic arches, and strong 'connecting crests' between the very stout triangular horns.

We can readily distinguish this species by the vigorous development of the canine, premolar and molar teeth, which far surpass in size and in the development of cingula those of any other type. (See measurements, Table II.)

Vertical or lateral crushing greatly alters the angles and appearance of the horns. Skull No. 1066 is vertically crushed, and thus closely resembles the type of *Menops varians* Marsh.

21. Titanotherium hypoceras (*Cope*).

Symborodon hypoceras COPE.

Type Loc.—Colorado. Level unknown.

Type.—A fragmentary cranium, parts of nasals, maxillaries, frontals, etc. (Am. Mus. Nat. Hist., Cope Coll., No. 6361.)

This species is indeterminate, owing to the fractured condition of the type. The horns resemble those of a young individual, or of a female skull.

22. Titanotherium montanum (*Marsh*).

Anisacodon montanus MARSH, Am. Jour. Sci. 1875, p. 245.
? SYN. *T. elatum* MARSH.
Diconodon (non-*Anisacodon*) MARSH, Am. Jour. Sci. 1876, p. 339.

Type Loc.—Not published.

Type.—A fragmentary skull, including the maxillaries. The chief character assigned to distinguish this genus and species is the large second internal cone upon the last upper molar ; this character is of very doubtful taxonomic importance, since this cone is a variable character, as we have seen above in *T. trigonoceras* and *T. ingens*. The dentition assigned by Marsh is: $\frac{0}{1}, \frac{1}{1}, \frac{4}{3}, \frac{3}{3}$.

The skull referred to this species by Marsh, in the National Museum Collection, resembles a female skull of *T. elatum*; the horns of transverse oval section are short, placed above the nares, directed forwards and united at the base by a strong connecting crest.

24. Titanotherium angustigenis (*Cope*).

Menodus angustigenis COPE, Ann. Rep. Geol. Surv. Canada, 1886, C. p. 81.
Haplacodon angustigenis COPE, Am. Nat. March, 1889, p. 153.

Type Loc.—White River Beds of Swift Current Creek, Canada.

Type.—Two maxillary bones. Assoc. type : Two lower jaws.

The characters of the type do not enable us to define this species satisfactorily. The *associated* type is readily distinguished by the extreme narrowing of the *symphysis mandibuli*. The type is interesting as exhibiting three premolars upon one side and two upon the other, and demonstrating the variability of these teeth. The genus *Haplacodon* has not been retained by its author.

25. Titanotherium tichoceras (*Scott & Osborn*).

PLATE III.

Menodus tichoceras S. & O. Bull. Mus. Comp. Zoöl. Aug. 1887, p. 157.

Type Loc.—South Dakota. Level unknown.

Type.—A skull and teeth ; horns partly broken. Coll. Harv. Univ. Mus.

Spec. Char.—*Horns* sub-triangular to cylindrical in section, rising between orbits and nares, inclined forwards and outwards ; not united by connecting crest. *Nasals* of medium length, slightly tapering. Zygomatic arch deep, with a bulge opposite glenoid facet. Occiput unknown. Two superior incisors. Premolars without external cingulum ; internal cingulum reduced or obsolete. Dentition : $^{2}, ^{1}, ^{4}, ^{3}$.

This species is clearly distinguished from the *T. trigonoceras* and *T. ingens* type by the decidedly more anterior position and more rounded section of the horns, by the correspondingly shorter nasals, and by the absence of external cingulum upon the premolars. It resembles these species closely in the form of the zygomatic arch. The sex of the type is uncertain; the rather large canines indicate that it is a male skull. It might be considered a female skull of *T. dolichoceras* but for the longer nasals and wholly different horn-section.

26. Titanotherium dolichoceras (*Scott & Osborn*).

PLATE IV.

Menodus dolichoceras S. & O. Bull. Mus. Comp. Zoöl. Vol. XIII, Aug. 1887, p. 158.

Type Loc.—South Dakota. Level unknown.

Type.—A male skull, lacking dentition and zygomatic arches. Coll. Harv. Univ. Mus.

Spec. Char.— ♂ *Horns* long, placed above nares, forwards and outwards, with an oval section placed obliquely to the longitudinal axis of the skull; no connecting crest. *Nasals* very short, tapering. Occiput not very broad. Premolars with reduced external cingulum.

The horns in this species are placed as in *T. robustum*, but the oval section is oblique instead of transverse, and the nasals are much shorter. This position and section of the horns is highly characteristic. A close approach to it is found in the type of *T.* (*Allops*) *serotinus* Marsh, which may prove to be a female skull of *T. dolichoceras*. The sections are shown in Diagram II.

27. Titanotherium platyceras (*Scott & Osborn*).

PLATE IV.

Menodus platyceras S. & O. Bull. Mus. Comp. Zoöl. Vol. XIII, Aug. 1887, p. 158.

Type Loc.—South Dakota. Upper Titanotherium Beds.

Type.— ♂ A pair of horns. Nasals imperfect. Coll. Harv. Univ. Mus. Assoc. type, Coll. Am. Mus., No. 1448.

Spec. Char.— ♂ *Horns* placed vertically in front of symphysis, extremely flattened transversely, directed forwards, upwards, and slightly recurved; united by a deep connecting crest; rugose at extremities, with an external ridge extending towards malars. *Nasals* extremely short, deeply notched. Zygomatic arches expanding into two broad flattened rugose plates. Occiput low, deeply indented, with stout lateral pillars. External auditory meatus enclosed by deep union of post-glenoid and post-tympanic. Canines stout, obtuse. Two pairs of upper incisors. Premolars with obsolete external cingulum. ♂ Dentition : 2, 1, 4, 3.

Fig. 7. *Titanotherium platyceras.* Skull (No. 1448), in lateral view. The occipital region is composed of fragments placed together in plaster. One-tenth natural size.

Fig. 7*A*. *Titanotherium platyceras.* Type. Horns and fragmentary nasals. Harv. Univ. Mus.

The characters originally assigned to this species from the type horns in the Harvard University Museum are now reinforced by a superb male skull in the American Museum Collection (No. 1448). It apparently represents the very latest stage of development of the Titanotheres before their sudden extinction. The extreme anterior position of the horns, their flattened section, the deep connecting crest, the vestigial nasals, the great zygomatic plates, the deeply excavated occiput—all are in a terminal phase beyond which further specialization seems impossible. At the same time it is noteworthy that in this skull both the incisors are retained and the last molar shows only a slight distinctness of the second cone, indicating that this character is not essentially a progressive one. The premolar cingula are markedly reduced. The horn sections are shown in Diagram I. The figures of the skull are inaccurate in not clearly indicating that the posterior part of the cranium is largely fragmentary and restored.

28. Titanotherium robustum (*Marsh*).

Brontops robustus MARSH.

Type Loc.—Upper Titanotherium Beds.

Type.—A perfect skull and nearly complete skeleton. Coll. Yale Univ. Mus.

Spec. Char.—*Horns* placed anteriorly, above nares, directed forwards and outwards, transverse oval in section, no connecting crest. *Nasals* somewhat below medium length, slightly tapering or nearly square distally. Zygomatic arch with a strong outward projection, rounded in outer section. Premolars with reduced external cingula. Dentition : $\frac{2}{1}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$.

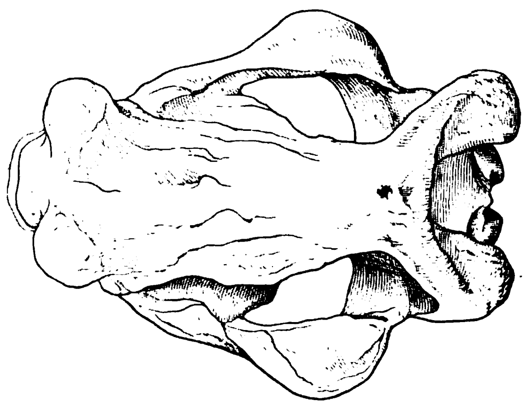


Fig. 8. *Titanotherium robustum.* Skull (No. 1069), in superior view. One-twelfth natural size.

Marsh's type is a superb skull and jaws and nearly complete skeleton, which was figured and fully described in 1889.[1] This

[1] Am. Jour. Sci., Feb., 1889, p. 163, Pl. vi.

animal approaches *T. torvum* Cope, but appears to differ specifically in the stronger transverse oval of the horns (compare sections in Diagram II), and in the less extensive outward arching of the zygomata. In *T. torvum* the expansion of the arch is somewhat flattened vertically ; in *T. robustum* the swelling is vertically rounded (as in Cope's associated type). These differences, however, may subsequently be found not to possess specific value.

Two fine skulls in the American Museum Collection (Nos. 1069, 1083) apparently belong to this species, although the nasals are somewhat longer and more quadrate distally. They exhibit the same transverse oval horn section, two strong upper incisors, the alveoli of powerful canines, the absence of a connecting crest between the horns.

Judging by the large upper canines, Marsh's type is the skeleton of a male, the sexual characters of this species have yet to be determined. Some light is thrown upon this by No. 508.

The skull and nearly complete skeleton (508) in the American Museum have already been described as a *female* of this species in a previous number of the Bulletin. Unfortunately the canines and alveolar borders of the incisors are wanting, depriving us of these characters so distinctive of sex. The horns are feebler, and the zygomatic arches are much less expanded than in Marsh's type, indicating that this is a female animal.

29. Titanotherium dispar (*Marsh*).

Brontops dispar MARSH, Am. Jour. Sci. 1887, pp. 327, 329.

Type Loc.—South Dakota Titanotherium Beds.

Type.—A nearly complete skull with lower jaws and entire dentition. Coll. U. S. Geol. Surv.

This species has not as yet been defined in such a manner that its position can be determined.

30. Titanotherium varians (*Marsh*).

PLATE III.

Menops varians MARSH, Am. Jour. Sci. 1887, p. 328.

Type Loc.—South Dakota. Titanotherium Beds.

Type.—" Skull of a large adult male."

Marsh has distinguished this species by the formula $\underline{2}$, $\underline{1}$, $\underline{4}$, $\underline{3}$. The horns are directed outwards and subtriangular in section, and the connecting crest is very low. The nasals are elongate, spreading, and notched distally.

We cannot, from the characters given, clearly distinguish this species from *T. trigonoceras* or *T. ingens*, to which it is apparently related.

31. Titanotherium curtum (*Marsh*).

PLATE IV.

Titanops curtus MARSH. (Type of Genus *Titanops.*)

Type Loc.—Colorado. Probably Upper Titanotherium Beds.

Type.—A complete male skull, with imperfect premaxillaries.

Spec. Char.—♂ *Horns* placed above narial opening, transverse flattened oval section, directed upwards, outwards and forwards, with an external crest to malars and a strong connecting crest. *Nasals* extremely reduced. Zygomatic arches moderately expanded. Canines powerful.

This species is intermediate between *T. elatum* and *T. ramosum.* The horn section is similar to that in *T. elatum*, but the nasals are very much more abbreviated.

32. Titanotherium elatum (*Marsh*).

PLATE IV.

Titanops elatus MARSH.

?SYN. *Diploclonus amplus* MARSH.

Type Loc.—South Dakota. Upper Titanotherium Beds.

Type.—A male skull lacking zygomatic arches.

Spec. Char.—*Horns* placed above anterior nares and symphysis; directed forwards, upwards and outwards; transverse oval (flattened posteriorly) in section ; united by connecting crest. ♂ Horns elongate, vertical and recurved, rounded at tip ; a strong external ridge to malars ; deep connecting crest. ♀ Horns short, projecting forwards, pointed, rugose, or imperfectly ossified at tips, connecting crest less prominent or wanting. *Nasals* ♂ ♀ rather narrow and short, tapering, somewhat variable in length and size, notched distally. Zygomatic arch spreading ♂ with broad, vertically-compressed plates ; ♀ with a stout rounded projection. Occiput low and broad, ♂ with powerful lateral crests, ♀ with moderate lateral crests. Incisors, ♂ 2-1, ♀ variable 2-0. Canines short, obtuse, ♂ powerful, ♀ small, feeble.

Marsh's type is an imperfect male skull which he has briefly characterized.

The above definition is from an exceptionally fine male skull (No. 492, Am. Mus. Coll.), and from a less complete male skull and perfect pair of jaws (No. 1070, Am. Mus. Coll.). These are apparently identical with Marsh's type. The *female* characters

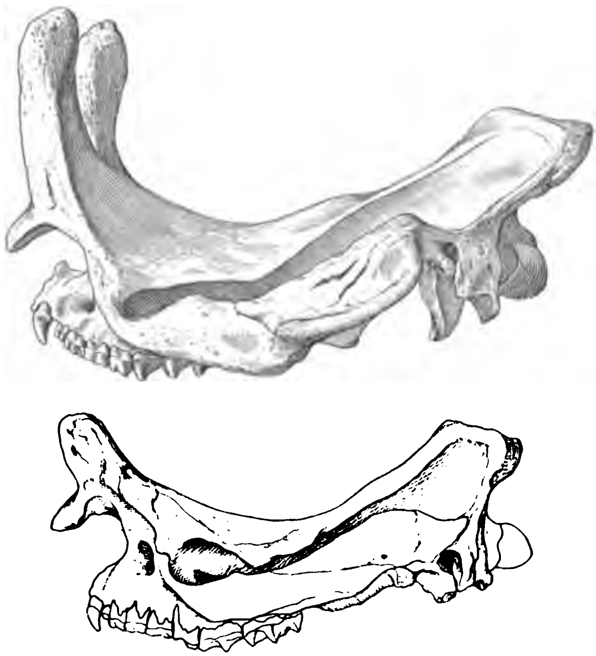


Fig. 9. *Titanotherium elatum.* Male (No. 492) and female (No. 1006) skulls, contrasted in lateral view. One-twelfth natural size.

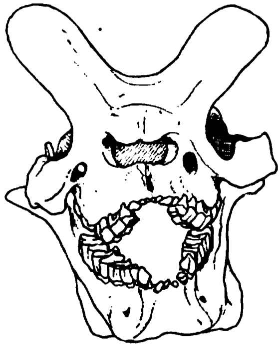


Fig. 10. *Titanotherium elatum.* Skull and jaws (No. 1070), in front view. One-twelfth natural size.

are taken from four smaller skulls found in the same geological level, distinguished by a rusty-brown color. In these skulls the horns are much shorter but have the same section, position and strong connecting crest, and it is highly probable that they are females of *T. elatum.* If this conclusion is correct we derive from these skulls a number of very important facts.

Both *male* skulls (492, 1070) exhibit a strong pair of upper incisors. The lower jaw of 1070 exhibits two lower incisors. No. 492 is characterized by short robust canines, very long recurved horns, massive zygomatic arches, extending into flattened plates, a robust deeply incurved occiput, small but well-formed nasals.

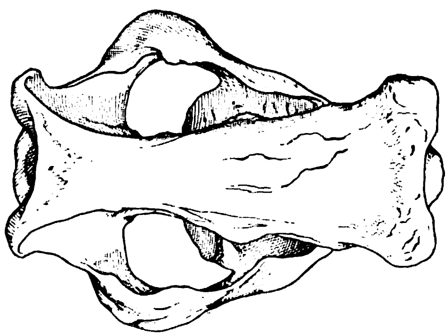


Fig. 11. *Titanotherium elatum.* Female skull (No. 1005), superior view. One-twelfth natural size.

In the supposed *female* skulls we find less perfect nasals, short horns, strong connecting crests, less expanded zygomata, feeble canines and extremely variable incisors.

In No. 1005, a small female skull, there are no upper incisors.

In No. 1006, a somewhat larger female skull, there is one small upper incisor upon each side.

In No. 1008, otherwise closely similar to the above skulls and found in the same level, there is also one small upper incisor upon each side, the horns are pointed (instead of rounded or obtuse as in Nos. 1005, 1006), and exhibit rugose projections upon the inner side about one-third from the base. This specimen agrees very closely with the type of *T.* (*Diploclonus*) *amplum* Marsh.

Fig. 12. Skull of female *T. elatum* (No. 1006). One-twelfth natural size.

Lower Jaws.

The very large pair of lower jaws (No. 1051) may be provisionally referred to this species, although the dental series is longer than in the male skull No. 492. They exhibit short, robust canines, two stout incisors, premolars without external cingula. The large mental foramen opens directly below the third premolar.

33. Titanotherium serotinum (*Marsh*).

Allops serotinus Marsh.

Type Loc.—South Dakota. Level not published.

Type.—A skull.

Marsh distinguishes this species by the dental formula $^1, ^1, ^4, ^3$. It has not yet been figured or defined. An examination of the type specimen indicates that skull No. 520, in the American Museum, is very similar. This in turn is most closely related to *T. dolichoceras.* This skull has small outer incisors only. The horns have no 'connecting crest'; they diverge widely and have an oval section, obliquely placed. The nasals are short and deeply notched; the zygomatic arches are moderately expanded. The summit of the occiput is more deeply incurved than in the type of *T. dolichoceras.*

35. Titanotherium selwynianus (*Cope*).

Menodus selwynianus COPE, Am. Nat. 1889, p. 628.

Type Loc.—Swift Current Creek, Canada.

Type.—Nasals detached from skull.

Spec. Char.—*Nasals* prominent, narrow and vaulted, lateral borders nearly parallel, extremities rounded.

This species is very imperfectly known. As described by Cope,[1] it appears to be a primitive and distinct species.

36. Titanotherium syceras (*Cope*).

Menodus syceras COPE, Am. Nat. 1889, p. 628.

Type Loc.—Swift Current Creek, Canada.

Type.—Coössified nasals with horns.

The type of this species resembles very closely the female nasals and horns of *Titanotherium acer* Cope.

37. Titanotherium amplum (*Marsh*).

Diploclonus amplus MARSH, Am. Jour. Sci. 1890, p. 523.

Type Loc.—Not published.

Type.—"A nearly complete skull."

Spec. Char.—*Horns* high, compressed transversely with a strong connecting crest; a prominent knob upon inner superior margin; an external ridge. *Nasals* projecting very little. Zygomatic arches widely expanded. Last upper molar with two cones. ? Two upper incisors.

[1] The nasals are figured in Pl. V, Figs. 3, 3*a*, 3*b*, Contr. Can. Pal., Vol. III, p. 17.

The above definition is from the author's description. The internal knob appears to be an *individual variation* rather than a specific or generic character. As above noted it appears in our collection in a skull which is probably a female of *T. elatum*, yet closely similar to Marsh's type of *T. amplum*. This knob is also seen in the horns of skull No. 1081 of our collection, which we provisionally refer to *T. torvum*.

38. Titanotherium avum (*Marsh*).

Teleodus avus MARSH, Am. Jour. Sci. 1890, p. 524.

Type Loc.—Not published.

Type.—Not stated. Characters assigned in lower jaw.

This species is characterized by the presence of three lower incisors in each jaw. The type has but three lower premolars. Hatcher believes that this species possesses a trapezium.

This character and the presence of three lower incisors unites this genus with *Diplacodon*.

39. Titanotherium ramosum, sp. nov.

PLATE IV.

Type. Loc.—Upper Titanotherium Beds. South Dakota.

Type.—A complete male skull, lacking incisor border. (No. 1447, Am. Mus. Nat. Hist.)

Spec. Char.—♂ *Horns* placed above symphysis, greatly expanded at the summits, section plano-convex ; a strong 'connecting crest,' *Nasals* extremely short. Zygomatic arches expanded into two wide flat plates. Incisors and canines unknown. Premolars with reduced external cingula.

The distal spreading or branching of the horns is the character by which this species is designated. It differs from *T. elatum* in this character, but more especially in the great depth of the 'connecting crest' and the extreme flattening of the horns, the section as shown in Diagram I, being intermediate between that of *T. elatum* and of *T. platyceras*. It is remarkable that the teeth in this large skull are relatively of small size; the last upper molar has no second cone.

Fig. 13. ***Titanotherium ramosum.*** **Type skull (No. 1447), in lateral view. One-twelfth natural size.**

Found near this skull was a pair of lower jaws (No. 1449) containing teeth of lesser longitudinal measurement. The chin is very shallow. There are two robust incisors upon each side; the canines are short and obtuse; the premolars lack the external cingula. The formula is $\frac{}{2}, \frac{}{1}, \frac{}{4}, \frac{}{3}$.

Characters of Lower Jaws.

It is not possible to satisfactorily determine the specific characters of the lower jaws from the materials at our disposal.

No. 516.—This is a fine pair of small jaws from the lower beds with a formula $\frac{}{2}, \frac{}{1}, \frac{}{4}, \frac{}{3}$. The dental series is of exactly the same size as in skulls Nos. 501 and 1445, indicating that these jaws belong to *T. trigonoceras*, but the incisors are much more strongly developed than in any of the known skulls of this species.

Nos. 1067, 506.—These jaws are both associated with female skulls of *T. ingens*. The rami are long and deep, with a full well-rounded chin. No lower incisors; strong cingula.

Nos. 6345, 6365.—These jaws, belonging to *T. torvum*, are much shorter and shallower than in *T. ingens*. No lower incisors; feeble external cingula.

Nos. 1052, 508.—These jaws, belonging probably to *T. robustum*, are distinguished by the very large size of the mental foramen, which is placed beneath the line between the third and fourth premolars. Canines stout in male (1052). Cingula feeble.

TABLE III.—DIVISION OF THE TITANOTHERIUM BEDS, AND VERTICAL DISTRIBUTION OF SPECIES.

		WHITE RIVER BEDS, COMPOSITE SECTION, OLIGOCENE.	CHARACTERISTIC SPECIES.
TOTAL THICKNESS, 180 FEET.	Upper Beds, 80.	Titanotheres of large and medium size. Males with horns 8 to 17 inches in length, placed above nares, transverse oval or flattened in section, usually a connecting crest. Nasals pointed, medium or short. Premolars with reduced cingula. Incisors 2–0. External auditory meatus deeply enclosed.	*T. platyceras*, 1448. *T. ramosum*, 1447. *T. elatum*, 492. *T. robustum*, 518.
	Middle Beds, 100.	Titanotheres of large and medium size. Males with horns 7 to 9 inches in length, placed above maxillaries, oval or triangular in section; sometimes a connecting crest. Nasals long, quadrate. Incisors 2–0. Premolar cingula varying. External auditory meatus always closed below.	* *T. tichoceras*. *T. ingens*, 505. * *T. trigonoceras*.
	Lower Beds, 50.	Titanotheres of medium and small size. Horns from 4 to 6 inches in length, placed above maxillaries, antero-posterior oval to sub-triangular section, no connecting crest. Nasals long. Incisors 3–0. Premolar cingula varying. External auditory meatus sometimes closed below.	*T. trigonoceras*, 501. *T. coloradense*. * *T. heloceras*, 6360.

No. 1051.—This jaw of unusual size is provisionally referred to *T. elatum.* The lower border reaches an angle below the fourth premolar, and in front of this extends upwards into a shallow chin. Cingula upon premolars feeble.

Nos. 1061 and 1068 represent the latest type of jaw, belonging either to *T. elatum* or *T. ramosum.* As in the above (No. 1051) the chin tapers rapidly upwards from a point below the fourth premolar. Cingula feeble.

III.—Distribution.

The relation of the evolution of the Titanotheres to the geological levels was first clearly pointed out in an important article by Hatcher.[1] The above table is his, with some modifications and the addition of the specific forms characteristic of the various beds so far as they are known. The geological level of the species marked with a * is still a matter of inference, not of record.

It is true that the above inductions as to growth, sexual and variable characters require confirmation by the examination of a very large number of skulls. In general they are probably correct. They indicate that the principles of generic and specific division adopted by Cope, and in a large degree by Marsh, are wholly untenable—for the strict application of these principles would multiply genera and species *ad infinitum.*

The phylogeny of the species is still so obscure that it is rash to speculate about it.

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[1] 'The Titanotherium Beds,' American Naturalist, March, 1893, p. 204.

Article X.—A TABLE OF THE GEOGRAPHICAL DISTRIBUTION OF AMERICAN INDIAN RELICS IN A COLLECTION EXHIBITED IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK; WITH EXPLANATORY TEXT.

By A. E. DOUGLASS.

This collection has been gathered by the writer during the last twenty years, and has been arranged in the various special classes irrespective of geographical division, with the design of illustrating the varieties of each class, and solving, as far as possible, the theory of their use by our aboriginal predecessors upon this continent. The importance, however, of the geographical distribution of the objects has not been overlooked, and a special Table has been constructed from the Records, designed to signify the localities whence the several relics were procured.

The writer has been urgently solicited by archæologists who have inspected this work, and whose opinion is of weight, to publish this Table as a compilation likely to be of much benefit to students, and in deference to this request, and in the hope of attaining so desirable a result, it is now, through the courtesy of the authorities of this Museum, presented to the consideration of those engaged in the study of American Archæology.

In forming conclusions based upon this Table a very large caution must be exercised. Common forms, such as arrow and spear points, celts, and many others, are so overwhelmingly abundant, that the collector is compelled to restrict their influx, and their appearance in this Table gives no correct idea of their relative prevalence. On the other hand he has aimed to collect, from every available source, special classes of objects, and the Table will justify conclusions, approximately at least, of their relative geographical distribution. Such classes are Banner Stones, Bird and Bar Amulets, Gorgets, Fleshers, Pestles, Discoidals and Discs, Club Stones, Pipes, Polishers, Drills, Hematites, and others. Many of these classes are capable of subdivision according to pattern, and are so arranged in the cases, but it has not been thought necessary to express these in the Table. Nor does the Table include some two thousand objects from other quarters of the globe than the American continent, which are found in this collection, the classification of such objects being radically different, and requiring a special enumeration, and, while of great importance in a comparative study of the artistic progress of the earlier races of the world in general, can have little bearing upon the purpose designed by the Table now presented.

The nomenclature adopted by the writer calls for some explanation on his part. When this collection was commenced, some twenty years ago, he found every class encumbered with sundry names varying as the fancy of the collector suggested. Many of these were approved by good authority at that time, but as the science advanced were shown to be based on incorrect or partial knowledge of the uses of the objects.

The *Banner Stone* was termed 'Ceremonial Axe,' 'Ceremonial Weapon,' 'Breast Ornament,' 'Wand,' 'Totem,' 'Mace Head,' 'Mace,' and other names, all sufficiently vague to cause confusion, and some of them applied quite as frequently to other classes of objects, so that, unless the specimen had been figured, one was at a loss to comprehend what class was referred to. When a considerable number of specimens of the Banner Stone class was collected, it was evident that, notwithstanding a large variation in pattern, they possessed certain characteristics common to all, viz. : a single cylindrical perforation along the length or breadth of the plane of the object, with flanges or blades or projections on either side and on the same plane. With more than two hundred specimens before him, it was evident to the writer that the term 'weapon' or 'axe' was not applicable even though qualified as 'ceremonial,' for by no possibility could such a resemblance be shown. As to 'Breast Ornament' that term would only merge this special form among innumerable others widely different in their characteristics, and is therefore not sufficiently distinctive. 'Wand' and 'Totem,' 'Mace Head' and 'Mace,' are liable to the same objection as well as that of being indefinite, and thus the earliest popular designation, that of

'Banner Stone,' seems to be the least objectionable. This name was suggested by its capability of being mounted upon a staff and borne before some dignitary as an indication of rank; and this was for long a favorite theory, and in some cases may have been the fact. Dr. Rau was of the opinion they were worn upon the person, and certain characteristics in many specimens would seem to confirm this notion, but, in the absence of any testimony in history as to their actual use, we prefer to assign the popular designation of 'Banner Stone,' and require all objects so classed to be capable of such use, viz.: possessed of one perforation along the plane of the length or breadth of the object itself.

The patterns of this class vary largely and are grouped, as far as practicable, in the following subdivisions: *Circular*, where the two flanges complete a circle of the whole object; *Battle Axe*, resembling a double-bladed battle axe; *Pick*, a rounded bar, either straight or curved, the ends tapering to a point; *Butterfly*, where the ridge containing the perforation has been cut away at one or both ends, thus resembling a short-bodied insect with over-reaching wings; *Bird Wing*, where the ridges have not been so cut away, and the flanges extend a considerable length; *Triangle Bar*, where the perforation traverses the length of a bar whose vertical section forms a broad-based triangle; *Rectangular*, where the sides and ends are parallel or square; *Conical*, where the flanges diminish in breadth from one end to the other; *Single Arm*, having but one drooping arm, and an oval instead of a circular perforation.[1] In this collection are seven of these rare objects, all beautifully finished, indicating this form to be the deliberate design of the artisan and not a repair of the accidental breakage of a companion arm. *Special*, is the last subdivision of this class, and includes special forms of great variety, freaks or fancies of the artisan, too eccentric to admit of subclassification, but, by conforming to the conditions before specified, entitled unquestionably to rank as Banner Stones.

The class here termed *Gorget* was also invested with an abun-

[1] A fine specimen from the Indian town of Hochelaga is figured in Sir J. William Dawson's 'Fossil Men and their Modern Representatives,' p. 118 (London, 1888), which he regards as an offensive weapon, an idea not confirmed by an examination of other specimens. Also 'Smithsonian Archæological Collection,' p. 23, fig. 92. and Thirteenth Annual Report of the Bureau of Ethnology' (Washington. 1896), p. 123, fig. 145, which is most likely a Single-arm Banner Stone, provided no fracture appears and the perforation is oval.

dance of synonyms. It has been designated 'Pierced Tablet,' 'Bowstring Gauge,' 'Badge,' 'Pendant,' 'Puzzle Block,' and other names founded upon theories of their probable purpose, but the special name here adopted was in use by experts in Indian trade and customs more than a century since, when similar objects in metal and of European make were donated to chiefs or traded to the various tribes, and were substituted for those of stone then worn upon the neck or breast. The Gorget is a plate of stone (generally stratified slate) invariably flat on one side and generally so on the other, the surface highly polished; symmetrical in outline and having one or more perforations through the plate. These perforations, unlike those of Banner Stones, are made with a conical and not cylindrical drill: they are sometimes wanting when otherwise the specimen is complete, presumably from the fact that the boring was left to some other manipulator or was a later process of the original artisan.

It is quite probable that while most of the objects included in the class of Gorgets were purely ornamental, many others may have subserved some industrial purpose. Such uses are as yet conjectural, and until generally determined by later research their intrinsic beauty of form and finish and suitability in other respects appear to entitle the specimens in question to rank as ornamental appendages, and they have been retained in this class.

In this collection we have nearly four hundred objects of this class, whose forms are so varied as almost to defy any attempt at subclassification, and this has been attempted only in the following instances where some common characteristic seems to bring several into line together. The *Spade Shape* is a flat plate of stone, finely polished and of even thickness, semicircular in shape, with a tang of about two-thirds its breadth, extending in form of a square from the upper edge. In this tang or projection are one or two perforations. It differs from Gorgets generally in having this semicircular blade brought to a moderately sharp edge.

It is a question whether this pattern should be included in the Gorget class. Schoolcraft,[1] in the second volume of his Indian

[1] 'History, etc., of Indian Tribes of United States,' Vol. II, p. 89, and plate xliv, fig. 3. Philadelphia, 1860.

Tribes, figures one from South Carolina, and considers it a 'Battle Axe.' Col. C. C. Jones, Jr.,[1] and Dr. Rau[2] both suggest, more reasonably, its possible use as a skin scraper; but that question is still unsettled, and, as an ornamental appendage, it has been here left to its original position as a Gorget. There are six specimens of this subdivision in the collection.[3] Another subdivision is the *Ovate*, comprising all specimens whose ends are symmetrically rounded, though the side outlines may be concave or convex or notched. *Leaf-shaped* includes specimens whose ends are pointed, with similar privilege as to side outlines; *Spear-shape*, where one end is squared and the other pointed; *Square*, where both ends are squared or the general form is of that character; *Ridged*, having the upper surface more or less elevated, sometimes rising to a point; *Expanded centre*, where the specimen is plano-convex in structure, the central portion widened or expanded and then gradually attenuating in width toward the ends, which terminate bluntly. The specimens embraced in these last two subdivisions have two perforations along the central line, which are peculiar in the fact that they are made by a conical drill from the base to the upper surface by one boring only; most other Gorgets show perforations made from both surfaces and meeting midway more or less exactly. There are sixteen specimens of this subdivision in the collection,[4] and they have sometimes been incorrectly called 'boat-shaped,' a term properly applied to objects of entirely different shape and purpose, as will be seen hereafter. As before stated, a large majority of the Gorget class is, from eccentricity of pattern, included under a subdivision of 'special types.'

Gorgets of Shell, so called because probably worn in the same manner as those of stone, are subdivided only as *Inscribed* and *Plain*. They number seventeen in this collection.

Amulets, so termed, as having most probably some supernatural signification, include *Aztec Amulets*, of jade and other semi-precious stones, occasionally carved and pierced for suspension, and the *Bird* and the *Bar*.

[1] 'Antiquities of the Southern Indians,' pp. 289, 290, plate xiv, fig. 14. New York, 1873.
[2] 'Smithsonian Archæological Collection,' p. 25, fig. 96. Washington, 1876. Also 'Twelfth Annual Report Bureau of Ethnology,' p. 245, fig 150, and p. 383, fig. 263.
[3] From Tennessee, 2; from Mississippi, Georgia, North Carolina and Kentucky, 1 each.
[4] From Ohio, 8; North Carolina, 2; Indiana, 2; West Virginia, Illinois, Georgia, and unknown, 1 each. Six of these specimens, finished in other respects, still want the perforations.

The *Bird Amulet*, as it is here termed, has been fancifully styled 'Knife Handle,' 'Brooding Bird,' 'Corn Shucker,' 'Saddle Stone,' etc. While opinions widely vary as to their use or exact signification, it is still evident that these objects mean to represent a bird, and are best described by the use of that name in conjunction with Amulet. The more complete specimens have a flat base bar, triangular or convex above, with the head and tail of a bird rising at an angle from opposite ends. At each end of the bar a diagonal perforation is made longitudinally through to the base, and is an invariable feature only except where the object may be presumed to be as yet incomplete. Occasionally the tail is wanting, and also the eyes. When the eyes appear they frequently project considerably and expand into a mushroom shape. Among the seventy Bird Amulets in this collection are seven with an expanded oval base, two with the projecting eyes but no apparent head, and one whose head is that of a turtle.[1] All these possess the proper perforations.

The *Bar Amulet*[2] is a bar, square or triangular, with terminal perforations similar to those above mentioned, but having no characteristic of bird or animal. These are rare objects, and seem never to have received a specific name, but the number here shown (38) would entitle them to some special designation, and the peculiar perforations, resembling those of the Bird Amulet, and not found elsewhere, have implied a possible similar signification, and they have been classed as 'Bar Amulets.'

Implements of Stone, of *Bone*, and of *Shell*, are divisions which include objects in those materials whose uses are unknown or at least questionable. In arrangement upon the shelves they are separated into patterns or types, which indicate a like use, whatever that use may have been.

Among these subordinate divisions are found sixteen specimens

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[1] One other instance of the substitution of a turtle's head for that of the bird is reported in the 'American Naturalist,' Vol. XVI, p. 1027, and Vol. XVII, p. 107, both describing the same specimen, found in Miami County, Ohio, in 1881. The one in this collection was found on the Thornton farm, two miles south of Auburn, Cayuga County, New York.

[2] Figures and description of the Bar Amulet appear in Dr. Abbott's 'Primitive Industry,' p. 375, fig. 356, Salem and Boston, 1881; and in Smithsonian Archæological Collection, p. 53, fig. 210. It is much ruder in appearance in Dr. Abbott's figure than usual, the specimens in this collection being remarkable for beauty of form and finish. They vary in length from two to eight inches, and exhibit the characteristic diagonal perforations, which, in a fractured specimen, has been renewed upon the broken end.

of the *Boat-shaped Implement.*[1] It resembles a boat in so many ways that the name seems to sufficiently identify it without designing to imply that such was the idea of the Indian artificer. These objects are from two to seven inches in length, worked to a point at each end, hollowed out more or less deeply, and rounded to a sort of keel below, which is sometimes furnished with a longitudinal groove. It has most frequently two perforations along its axis, running through the bottom of the boat at either end, though three specimens, of great beauty of shape and finish, show no perforations.

The class termed *Celts* is too well known to archæologists to require description here. The form, with more or less modification, prevails throughout the world, but our native product of this implement does not yield in symmetry of form or beauty of finish to the best work of other continents. The synonyms under which it appears in our literature are 'Tomahawk,' 'Wedge-shaped Axe,' 'Hand Axe,' 'Hatchet,' etc. The best authorities in England and America—Sir John Evans[2] and Col. Charles C. Jones, Jr.[3]—prefer to call it 'Celt,' and this term, derived from the old Latin *Celtis*, signifying chisel, has been largely used, and seems less objectionable than the others above named, which imply a hafted implement. When we consider that our aborigines made the grooved axe almost as abundantly as the celt, and were easily familiar with that mode of attachment to a handle, it is inconceivable that they would have expended so much labor upon the smoothing and polishing of the celt without allowing a groove or at least an unfinished section of the surface for the attachment of a handle if they intended to haft it. While hafting may by some urgent necessity have occurred in a few instances, it could not have been a general custom, and a careful examination of some twelve hundred celts, large and small, in this collection, shows but fifteen that give any indication, by groove or local roughening, of having been hafted. A vast majority, by their unblemished and unsplintered edge, imply that they could only have been used for soft work, and when we con-

[1] The Boat-shaped Implements are, from Ohio, 4; Georgia, 3; Tennessee, 3; North Carolina, 2; Kentucky, 1; Mississippi, 1; Arkansas, 1; unknown, 1. *Cf.* 'Smithsonian Archæological Collection,' p. 33, fig. 135, and 'Primitive Industry,' p. 382, fig. 362.
[2] 'Ancient Stone Implements of Great Britain,' Chap. III, p. 50. London, 1872.
[3] 'Antiquities of the Southern Indians,' p. 278. New York, 1873.

sider the abundance of garments made from skins recorded by early historians, and how these were prepared, and also the mode of excavating canoes from tree-trunks by successive burnings and chiselling of the charred wood, both of these extensive industries implying hand-use, it seems but reasonable to adopt a designation as little confusing, as regards suggesting any other mode of use, as the one here given to this implement.

The class termed *Flesher* is an implement resembling in some respects the celt, and most generally so called, but it is plano-convex in structure, and that form appears most suitable for flaying or skinning animals, from which it has been termed 'Skinner' and also 'Bark-peeler,' which purpose it also answers. The lower surface is flat, slightly curving upwards as it approaches the edge where it meets the upper and convex surface. There are thirty-five specimens of this implement.

Gouges and *Adzes* are terms well understood, and these implements appear to have been used by the Indian in the same way as our metal tools of the same name at the present day, while they possess those familiar shapes. The Gouges in some cases indicate, by knobs upon the back, that they were to be hafted, and the Adzes, also knobbed, have occasionally a gouge-like, cutting edge.

The term *Chisel* is applied to bars of stone, long and slender, both square and round, tapering at one or both ends to a sharp cutting edge. They are subdivided into 'Square,' 'Round,' and 'Flat,' this last representing very thin elongated celts, which must have subserved such a purpose.

The *Grooved Axe* is one of the common well-known Indian implements which needs no description. Although a few specimens have been found in Europe, they are there so exceedingly rare that they may be considered peculiar to the continent of America. In this collection there are 419 objects of this kind, varying from 14 inches in length and of 17 pounds weight, to the size of a child's toy only 1¼ inches long, probably merely ornamental. They are generally finely made, though those from New England are mostly of rude form and extremely flat and broad. The groove at times entirely encircles the blade, but frequently is wanting upon the edge next the handle, where the surface is left flat, or slightly concave, presumably to permit the insertion of a wedge and thus tighten the withes when slackened by continuous use.

The *Grooved Maul* is often simply a grooved axe deprived of its cutting edge by fracture or grinding. The larger ones are frequently natural pebbles or boulders, grooved about the middle for hafting. They answered the purpose of our sledge hammer when of considerable size and weight. The smaller sizes no doubt were hafted and covered with skin, leaving only one striking face exposed, and thus answered for a weapon in war, or the chase of the larger wild animals.

Hammer Stones are almost universally oval or disc shaped pebbles, of small size with slight depressions in the centre of each side for the better grasp of thumb and finger. The bruised edges indicate their mode of use.

Anvils and *Cupped Stones* comprise a series of stone blocks, generally boulders, which have upon their surface one or more depressions about an inch in breadth and depth, supposed to be for breaking walnuts or for grinding paints or for sockets for reed drills. A generally bruised surface indicates their occasional use as 'Anvils.' They have been styled 'Nut Stones,' 'Spindle Rests' and 'Paint Cups,' suggested by these possible uses.

Pestles are rounded bars of stone used in mortars of stone or wood for crushing grain. They are frequently carefully made, tapering toward the handle end, which terminates in a knob. Their length in this collection varies from two to thirty-three inches, the smaller ones being frequently natural pebbles of suitable form. This elongated bar seems to have been peculiar to the Northern Atlantic States. West of the Alleghanies and to the Rocky Mountains the Pestle was from four to eight inches in length, and expanded to a much broader and flat base in which appears a small central depression. Beyond the Rockies to the Pacific Coast, the Pestle is generally from eighteen inches to two feet in length, capped with a well-carved knob, and gradually enlarging thence to the other extremity. The three subdivisions of this class are therefore 'Round Bar,' 'Bell-shaped' and 'Knobbed,' representing these several forms.

Mortars are either rude or dressed masses of stone, more or less depressed upon one surface for receiving grain or other material designed to be crushed.

Picks and Hoes comprise an extensive series of agricultural implements of chipped chert, largely from the Mississippi Valley. They are long, narrow, and rather thick blades, from three to eight inches in length and one to four in breadth, sometimes with parallel sides and rounded at the ends, and on all sides trimmed down to a rude edge, or again wide at one end which is slightly pointed, and diminishing gradually toward the other. One end generally shows the brilliant polish effected by long use in a soft soil. The term 'Picks' is applied to the narrow implements of this class, presuming they have not been used so much for lifting or removing soil as for making holes to receive seed. The 'Hoes' indicate by the breadth of blade their probable use as named, while a subdivision is that of 'Notched Hoes,' which are blades of thin chert nearly circular in shape, on one extremity of which are two deep notches affording hold for a withe or cord, by which a handle may be attached against the face of the implement, much resembling hoes in present use. These notched hoes are extremely rare, and, so far as known, are only found in southern Illinois, eastern Missouri and west Kentucky. In this collection are thirteen specimens, varying from four to seven and a half inches in greatest diameter. They are of brown chert, and the polish of the lower edge indicates a prolonged use.

Much larger implements, used much in the same way are classed as *Spades*. These are generally long, oval shaped slabs of chert, flat on one surface and convex on the other, ranging from a length of eight inches and a breadth of four, to that of fifteen and a breadth of five. There are other exceptional forms, principally fan shaped, and all indicate a considerable use by a brilliant polish upon the edge. Though it is possible to use them as hand implements for one or both hands, it is not unlikely that they may have been fitted to a handle and used as our shovel of the present day.

The term *Discoidals* was found by the writer in general use, and as it simply identified a shape without implying a use possibly questionable, it seemed proper to adopt it. Objects having the character of discs vary so greatly in size that it seemed more convenient to make a division into two classes, one of 'Discoidals,' embracing those having a diameter of three inches and over, and one of 'Small Discs' and 'Spindle Whorls' including those of a less diameter. The class of Discoidals therefore includes the objects commonly known as 'Chungkee Stones,' and the probabilities are that most all so classed in this collection—while possibly having in some cases had a secondary use as mortars—were designed for use in the game of Chungkee or its like. A Discoidal is a circular wheel or disc of stone from three to eight inches in diameter, and from one to one and a half inches in extreme or marginal thickness. The specimens are of various kinds of stone, frequently of white or yellow quartz, and are of remarkable beauty of finish. The subdivisions are, the 'Convex,' the sides of which are slightly convex; the 'Concave,' deeply hollowed on both sides; 'Concave Pitted,' having in the centre of each concavity a slight depression, which is sometimes placed upon an elevated point in the centre of the hollow; 'Concave Pierced,' where the centre is perforated; 'Bevelled Edge,' discs with plane surfaces, and edge slightly bevelled, as described by Le Page du Pratz[1] in referring to the game as played in Louisiana. All the specimens in this subdivision, seventeen in number, come from States south of Virginia and Kentucky. The surfaces are not pitted. The 'Cheese Form' is the last subdivision, and seems so unsuitable for use in the game of Chungkee, or perhaps any game whatever, that it might be considered as a distinct class. These objects are cylindrical forms of stone, equal in height and width, ranging from three by three inches to six by six, and slightly convex on the ends. Of the fourteen specimens in this collection[2] several show traces of exposure to fire, and this with their suitability for such a purpose, suggests the possibility of their use as pot-rests.

Small Discs include all disc-shaped objects less than three inches in diameter. They comprise as subdivisions, 'Bevelled' (sometimes called 'Bung-shaped') discs, having a bevelled edge, shading gently into the lower surface, which is slightly convex, while the upper surface is flat and comes sharply to the upper side of the bevelled edge. They resemble the bung of a large cask. They are quite abundant in western North Carolina and eastern

[1] 'Histoire de la Louisiane,' Vol. III, p. 2. Paris, 1758.
[2] Tennessee, 9; New Jersey, 3; North Carolina, 2.

Tennessee, and may fairly be presumed to have been mullers or crushers of some sort. Another subdivision of this class is that of 'Spindle Whorls.' These are flat or slightly concave discs perforated through the centre. While this fact would imply most naturally such a use, it is possible that several of them may have been buttons for games. Certain marks on several would seem to indicate a value as objects for play. While a large majority are of stone, others are of earthenware chipped into shape. Another subdivision is that of 'Simple Discs,' imperforate, with flat or convex, or concave surfaces. Most of these were probably used for games, and those with concave surface possibly as paint cups. They range from one-half inch to two inches in diameter.

Passing by several classes whose titles do not require elucidation, we have that of *Club Stones*, of which there are 17 of stone, and 21 of iron ore. These are egg-shaped objects with the small end flattened or hollowed for attachment to a staff or handle by a casing of skin. Eighteen of those of hematite or other iron ore are strongly magnetic, and would almost suggest an Indian's knowledge of this property, though their great weight in small compass was probably the reason of their selection. They are remarkably symmetrical in shape, notwithstanding the labor required to work such obdurate material.

The class designated *Tubes* and *Perforated Stones* includes a large variety of implements or ornaments, tubular in shape, and destitute of the flanges or wings which would bring them within the class of Banner Stones. Of the subdivisions the 'Hour Glass' is a well-known pattern, resembling two slender cones united at their apices, encircled there externally by one or two raised bands, and excavated throughout in corresponding shape. Of these there are seven specimens. The 'Cylindrical' subdivision includes all round perforated rods, sometimes of slightly expanding diameter towards one end, from two to twelve inches in length, and frequently highly polished. The 'Flat Base' is another subdivision, having one side slightly flattened and resembling large beads. These are generally of stratified slate, and are finished with great care and delicacy.

Pipes constitute a very extensive class in this collection, numbering in all some 375 specimens. Every collector will appreciate the difficulty of determining, with any approach to accuracy, the age of such objects. Before and since the advent of the European, the fabrication of pipes has been a continuous industry, and while Indian tribes exist, cannot be expected to cease. Pipes made by the white man for purposes of trade, and on patterns that suit the barbaric taste of the Indian, also intrude and intermingle with those of native handiwork. This is not so likely to be the case with pipes made of the harder stones as with those made of steatite or earth or clay; but the Indian artisan of the Post-Columbian period has gained expertness from contact with the skill of the European and familiarity with his tools, and emulates him in the grace and elegance of his productions. So it follows that specimens of fine work may be the product of the enlightened Indian of the last three centuries, and thus the question of pre-historic origin will need to be determined by the facts regarding the *provenance* of the specimens under consideration. To obtain this information is extremely difficult and often impossible, as every collector knows. Specimens have often passed through many channels, from the finder to the collector, and from one cabinet to another, until their pedigree has been lost. Most of the pipes in this collection, however, have a well-established record, from which their Pre- or Post-Columbian origin may be argued. Among the latter are a few clay pipes of English and Dutch make, having manufacturers' marks, and taken from Indian graves in New York and Pennsylvania, which have a value in determining the date of an interment. The subdivisions of this class are as follows:

Human Sculpture	Pipes bearing human head, face or form	30	specimens.
Bird Sculpture	Pipes bearing bird's head or figure	23	"
Animal Sculpture	Pipes representing animals or reptiles in whole or part	39	"
Platform Pipes	Bowls set on broad thin plates, pierced for stem	12	"
Shield Pipes	Bowls with shield to be pressed to lips without stem	6	"
Tubular Pipes	Bowls and stems in same plane or direction	21	"
Trumpet Shape	Bowls flaring and long tapering stem	13	"
Solid Bowl	Bowls with aperture in same for stem	46	"
Double Bowl	Two bowls on one shaft or stem	2	"
Double Stem	Bowl with two or more stems	4	"
Right Angle	Bowl at right angle to stem	103	"
Obtuse Angle	Bowl at obtuse angle to stem	39	"
Foreign	British and Dutch pipes found in Indian graves	13	"
Unclassified and fragmentary bowls and stems		24	"

These subdivisions were adopted some years since at the suggestion of a friend who had made a special study of pipes, and contributed largely and learnedly to our literature on the subject. As will be seen, some prominent characteristic has given the name to each subdivision, and, when these are wanting, the 'Tubular' or 'Right Angle,' or 'Obtuse Angle,' include the remainder only, notwithstanding the fact that the first four divisions may comprise right or obtuse angle or tubular pipes. In the absence of any other known subdivision applicable to a class so numerous, and of such infinite variety in type, this system of subdivision has been retained, although perhaps not as satisfactory as could be desired.

The class of *Whetstones* includes all stone objects, large or small, whose form or surface gives indication of having been used for grinding, sharpening, or smoothing implements of stone or wood, and is subdivided into 'Hones' and 'Arrow-smoothers,' the latter having the surface furrowed, presumably for that purpose.

Polishers is the title given to a large number of stone objects probably used for polishing or rubbing skins or burnishing pottery. They are subdivided as to form into 'Square,' 'Oblong,' 'Conical,' and 'Natural Pebbles.' The latter necessarily must give some evidence of having been so used. They are generally carefully and symmetrically finished, and of the finer-grained stone.

Pendants, *Plummets* and *Sinkers*. This is a conglomerate class, including a great variety of objects, ornamental or useful, evidently susceptible of suspension. They are made of stone, of hematite and shell, and exhibit every kind of finish, from the finest and most symmetrical carving and shaping, to the rudest sort of adaptation by grooving a flake or pebble. The subdivisions of this class are 'Pendants' and 'Sinkers.' The former is used in a restricted sense, and implies a use as an ornament for the person. It is a round or cylindrical or pear-shaped bar, furnished with a groove or perforation at one end for suspension. It is sometimes banded with one or two rings in relief at one or both ends. So many ornamental objects of Indian make are pendant upon the person, though ranking as Gorgets, or in other classes according to their characteristics, that the term Pendant, as here used, is restricted to such objects as comply with the above description. The other subdivision, that of 'Net-Sinkers,' includes a large assortment of stone and shell pear-shaped objects, grooved or perforated at one end, mostly obtained from the surface of Florida shell-mounds; also stone masses of oblong or spherical form or egg-shape, encircled with a groove or pierced at the head, all of which possibly have been sinkers for nets in fishing, and forcibly suggest that use.

Natural Pebbles and *Balls* include a large number of symmetrically-shaped pebbles, found in Indian mounds, and serving the purpose of games of some sort, or valued for their form, with possibly a superstitious veneration.

Paint-cups are a series of very small cups or mortars, supposed to have been so used, made both of stone and earthenware.

Limonites are pebbles of this well-known mineral, selected apparently for their beauty of form. Many of them might have been used as paint cups, though generally too small to have been of service in that way. These have been gathered from mounds, as has also the class of *Mound Relics*, etc., which covers a mass of indiscriminate material, including fossils and concretions of ore and stone.

The following classes, *Beads of Bone*, *Stone*, *Shell*, *Glass*, sufficiently explain themselves. It should be observed that the numbers in the Table do not always indicate the number of the beads, which would otherwise amount to several thousands. Of the larger beads it occasionally expresses the number, but those from Florida mounds as often in compact masses incapable of separation, and with a vast quantity from Central New York, are only numbered by lots or parcels, and the same may be said of the strings of Wampum. In this case, as well as in those cases which have been previously excepted (Celts, Grooved Axes, Arrow and Spear-points), the Table affords no opportunity of estimating the relative prevalence of these objects.

The class of *Arrow Heads* is exceedingly numerous and of great variety of form. The name is given to all such objects as do not exceed two and a half inches in length. The subdivisions of this class are, 'Tiny,' being less than one inch in length;

'Small,' from one to one and a half inches in length ; 'Medium,' one and a half to two inches ; 'Large,' from two to two and a half inches. On the shelves these subdivisions are again arranged according to pattern, viz. : 'Triangular,' 'Lozenge-shape,' etc.

Spear Heads includes all spear-shaped objects exceeding two and a half inches in length. The subdivisions are : 'Small,' from two and a half to three inches ; 'Medium,' from three to four inches, and 'Large,' over four inches in length. These subdivisions are again arranged as to pattern, as in the case of Arrow Heads, such as, 'with or without Tangs,' 'Barbed and Unbarbed,' 'Lozenge-shape,' 'Triangular,' etc. It must be borne in mind that the names 'Arrow' and 'Spear' are applied to these objects from the white man's point of view rather than from that of the Indian. Many of the large Arrow Points were used as knives, scrapers and perforators, while the Spear Points, with very rare exception, must have been used as knives, considering the fact that Javelins or Lances were almost entirely unknown among the savages at the time of the advent of the European ; and it may also be observed that probably these chipped implements were turned out from the Indian workshop notched or tanged and ready for conversion into any state which the possessor or purchaser might desire ; that in fact these appendages constituted their normal condition, without regard to the use to which he might desire to apply them. The name 'Spear Point' has, however, become so universal for chipped implements apparently adapted to that use, that it does not seem desirable nor indeed possible to displace it by any other appellation. Several specimens of this class reach twelve inches in length, and one measures fifteen and a half inches.

Drills or *Reamers* are a class of flint or chert chipped implements designed to perforate any material by turning or punching. They number 327 in this collection, and in many cases retain the tang and barb belonging to the spear and arrow head from which they have frequently been fashioned. The subdivisions include the 'Double-end,' viz. : long and slender bars finished with the greatest care and pointed at both ends. 'Needle-point,' a beautiful and delicate point one-quarter of an inch in length upon the apex of an arrow-point, designed no doubt for fine threadwork upon moccasins or belts. Six of these latter objects in this collection are probably unique. 'Pipe Drills,' long, flat bars, gradually broadening from point to butt, slightly concave on the sides, suitable for boring the stems of the massive stone calumets. One of this kind may be considered as unique, since the butt is furnished with a semi-elliptical blade with symmetrically rounded edge, suitable in shape to finish off the hollow of the pipe-bowl after being rudely excavated.

Scrapers is a class of small chipped flint or chert implements, no doubt used as the name implies. They are generally thin blades or discs worked to a sharp edge, and frequently show the notches peculiar to arrow and spear points, not for the purpose of hafting, but from being shaped from the normal forms before mentioned, or from arrow or spear points injured by fracture. These latter are subdivided as 'Notched'; the circular as 'Disc'; while others, with length exceeding breadth, and chisel-ends, are named 'Elongated.' These implements were indispensable adjuncts to the Indian artisan's stock of tools, and are exceedingly abundant, this collection including more than a thousand specimens.

Ornaments of Stone and of Bone are classes presenting such varieties of pattern as to be incapable of subdivision. They are mostly pendant in character, and very finely and delicately finished in attractive material.

Ornaments of Shell are of a like variety, and have a partial subdivision of 'Hair Pins' and of 'Engraved Discs.'

Recurring again to chipped implements, we have the class termed *Knives*, comprising all implements of stone which have generally been so named from the likelihood of their having served the Indian in that capacity. The subdivisions are: 'Ovate' or elliptical, 'Leaf-shaped,' long, narrow and pointed at both ends, and sides convex; 'Spear-shaped,' having parallel sides but one end pointed, the other square or slightly concave; and 'Semilunar,' a half-moon in shape, not chipped but rubbed smooth, and furnished occasionally with a ridge or rim along the upper margin for the better grasp of the hand. All the blades of this class are chipped down to extreme thinness, and the 'leaf-shaped,' in several specimens, exceed six inches in length by three in breadth, one specimen being eleven inches by three in dimensions. This implement was quite as indispensable in the Indian life as the scraper, and the number in this collection is therefore very large, being nearly five hundred.

Flake Knives are unworked flint or chert or obsidian flakes, as struck from a core, and serving such a purpose. Excepting in States where obsidian is abundant, they are a somewhat rare object on this continent.

Flakers, or flaking tools, is the name given to short, thick rods of chipped flint or chert, presumably used in the process of chipping other flint implements. This term is applied by Sir John Evans (p. 369 of 'Ancient Stone Implements of Great Britain') to similar objects which he conceives to have been so used. They are about the size of a finger, are not cores, but have been chipped into shape with care and precision. In length they vary from two to four inches, and, so far as this collection is concerned, appear only in Missouri.

Cores and *Nuclei* are the blocks of chert, flint or obsidian from which, as their surface indicates, flakes have been struck. When of chert or flint they appear here only from Missouri, and when of obsidian mostly from Mexico and Central America. Their scarcity in the United States may be attributed to the collector possibly regarding them as worthless, but they are very rare in collections generally.

Bunts[1] is a term applied to flints shaped into convenient forms for storage or transportation, but as yet unformed as finished implements. The name has been used more than fifteen years, and comes to this collection from the previous owner of objects from Missouri which the writer secured by purchase more than ten years since. It served to particularize a series of flint blocks worked into merchantable shapes, to which no specific name had been given, and, though of itself not suggesting any characteristic

[1] Mr. John P. Jones, of Keytesville, Missouri, adopted this word 'Bunt' about twenty years ago. In 1880, when the writer acquired that collection, for the reasons above given, the name was retained in the same sense as employed by Mr. Jones. In 1878 it was used by Dr. Haldeman ('Am. Antiquarian,' Vol. I, p. 79) as a synonym for the blunt Arrow Head, and recently in a like sense, by the writer on 'Stone Art' in the 'Thirteenth Annual Report of the Bureau of Ethnology,' 1891–92, p. 168. It does not appear as a dictionary word in any archæological sense, direct or implied, and its selection seems to be purely arbitrary. It would be interesting to know whether any other mention has been made of the word as an archæological designation, and whether Mr. Jones has not a prior claim to the use of the term 'Bunt' in the sense here employed, which certainly supplies a long-needed want in our nomenclature of Indian relics.

or quality of these objects, was yet so comparatively an unused word as to permit it to be adopted here, without conflict with any meaning otherwise likely to be confusing. The name has only been here applied to the Missouri specimens, other objects of the same class having been previously included among 'Implements of Stone.'

Shell Calabashes are, as the name implies, drinking vessels made from the large conch, by cutting out the columella, and trimming the edge to suit. They are from Florida sand mounds.

Ornaments of Gold and its Alloys include a large series of those objects, exhumed from Huacas, in South America, and a single one from the peninsula of Florida. They are massive nose and ear labrets, figures of gods, necklaces and rings, beads, hair pins of gold, more or less pure, and number 155 specimens.

Bronze Ornaments and *Implements* are objects in that material from Mexico and Peru.

Quippus and *Cloth* are from Peru.

The title *Flageolets and Whistles* comprises four of the former (from Mexico), and five of the latter from a Missouri mound. These whistles, made from limonites of pear shape, from which the clay core has been extracted, and the orifice trimmed to a sharp edge and perforated for suspension, are believed to be unique.

The next series is that of *Aztec Stamps* and *Seals*, of which there are 51 specimens, all from the valley of Mexico. They represent designs and patterns of great beauty, as well as figures of gods and animals, and are supposed to have been used for decorating the person in colors for public festivities.

Copper objects includes a moderate display of objects in that metal beaten into shape, and occasionally ornamented with raised figures. These objects have been subdivided into classes corresponding with those in stone, which they resemble. They are principally from Ohio.

The collection now under consideration closes with a most extensive and varied series of objects in *Hematite* and other *Iron Ores*. They number in all about eleven hundred specimens, of which about 1050 are in red hematite, and the balance in the brown hematite and other ores of iron. This is believed to be the largest single collection of hematite objects in the country, and shows conclusively the appreciation of the Indian for beauty of form and symmetry in proportion, and that he spared no labor in expressing this feeling in the hardest and most obdurate material. These specimens appear to radiate from three great centres, viz.: West Virginia, southeastern Ohio, and central Missouri, and thence extend in diminishing frequency into the adjacent States. The subdivisions are, the natural nodules or 'Mineral Lumps,' the 'Paint Lumps,' whose surfaces show evidences of rubbing to obtain the paint so common among the tribes from Florida to the north and west; 'Balls and Hammer Stones,' shapes worked from the most obdurate ore; 'Grooved Axes,' from an ounce to eight pounds in weight, the largest being exquisitely polished; 'Celts and Cutters,' from half an inch to seven inches in length; 'Grooved Plummets and Sinkers'; a large number of 'Burnishers' of very varied shapes, and 'Pear-shaped Pendants,' finely proportioned, which may have been ornaments and yet possibly weights for weaving.

A few words upon the arrangement of this collection seem to be called for before concluding this article.

The purpose of the writer has been so to arrange the various specimens of presumably prehistoric Indian work as would enable the student of American Archæology to determine with the least labor to what class and subdivision of that class any object in his possession properly belonged, and by comparative study of the specimens in that class, to decide how they were used. For general anthropological purposes, a geographical arrangement seems to be most desirable and should by no means be disregarded. But in the study of special classes, the latter mode of arrangement presents the difficulty of accurately comparing characteristics when the specimens are scattered in small parcels through numberless cases in an extensive museum, and mingled with vast quantities of miscellaneous matter to which they have no sort of affinity, and which distract and confuse the observer. It seemed therefore desirable, that at least one collection should, in a circle of great educational centres, be arranged in this manner, and serve as a standard for all questions of classification throughout that circle. These centres might be New York, for New England and North Middle States ; Washington for Southern States, and Chicago for the West. It must be obvious to all that the nomenclature of Indian Relics is at present in a very confused state. The names given by collectors and essayists to the objects they describe render it quite impossible, without a figure, to conceive the nature of those objects. In the present collection not only are the classes and their variations segregated as described, but a fixed nomenclature has been adopted based on the best authorities in American Archæology, except in a few instances where a more thorough study and later developments have shown the older designation to be erroneous. Hardly anything is so perplexing in the reports of field explorers as the names given to objects of their find, without a figure to guide the reader, nor is it more satisfactory to the student to read admirably illustrated essays emanating from sources of conceded high authority, where palpable misnomers are applied to the objects figured, and involve him in a sort of hopeless bewilderment.[1] A point in our knowledge of American Archæology has surely been reached when this matter of nomenclature could and should be definitely settled, and perhaps this could most effectually be accomplished by a committee appointed at an annual meeting of the American Association for the Advancement of Science, selected from the Section on Anthropology, who should consider the subject and report their conclusions at the next annual meeting of the Association.

As the Association includes members from our most prominent museums most capable of determining such questions, their con-

[1] A very able, interesting and instructive essay upon 'Stone Art,' in the ''Thirteenth Annual Report of the Bureau of Ethnology' (Washington, 1896), displays a series of misnomers exceedingly confusing to the reader. They occur between pages 121 and 125. Figure 135 is not 'Boat Shape' but a Gorget with 'expanding centre.' Fig. 136 is not a 'Gorget.' It is represented in this collection by seven specimens. resembling the longitudinal half of an ordinary peg-top, and never perforated, but with or without a groove at one or both ends. They are all from Ohio, and would be termed 'Pendants' or 'Plummets.' Figs. 137 and 138 are unquestionably 'Boat Shaped Implements,' not 'Banner Stones.' Fig. 139 is not a Banner Stone nor 'Reel Shape,' but a 'Pendant.' Fig. 140 is a Banner Stone, though it does not comply with the description in the text. Fig. 141 is a Banner Stone of 'conical' outline and not 'crescent.' Figs. 142 and 143 are Banner Stones of 'Butterfly' pattern and not 'crescent.' Fig. 144 is a Banner Stone, 'Reel-shape' and not 'Butterfly.' Fig. 145 is possibly a 'Single Arm' Banner Stone, provided no evidence appears of fracture of a companion arm. Fig. 147 is a Banner Stone, 'Curved Pick' pattern, and in no sense 'Boat Shaped.' Fig. 148 is also a Banner Stone, of 'Semilunar' pattern and not a 'Boat Shape.' Fig. 150 is a Banner Stone of the 'Pick' pattern. Fig. 149 is a Banner Stone of the 'Bird Wing' pattern, and not a 'Pendant.' It is quite unaccountable how such errors should have crept into an otherwise valuable contribution to our literature on Indian Art on this continent.

clusions would carry decided weight and relieve the student from much that is at present annoying confusion and perplexity, to say nothing of supplying a satisfactory basis for the records of field exploration.

Article XI.—THE TEMPLE OF TEPOZTLAN, MEXICO.

By M. H. Saville.

Plates V-IX.

Introduction.

This old temple, called by the Indians "La casa del Tepozteco," has remained unknown to others until a few months ago.[1] The existence of tombs in this region is indicated in the archæological map of the Republic of Mexico, published by Leopold Batres in 1886, but no data is to be found bearing upon this temple.

It is due to the enthusiasm of Mr. Francisco Rodriguez, a young civil engineer, and a native of Tepoztlan, that we are now able to give a description of this most interesting structure. During the months of August and September of the past year, Mr. Rodriguez was engaged in the excavation of the temple with a large force of Indians who voluntarily gave their services, and to-day take great pride in the result of their labor.

Mr. Rodriguez read an account of his explorations before the Congreso de Americanistas, held in Mexico during the month of October, last autumn.[2] A résumé was published in a small paper recently started in the town of Tepoztlan, under the title 'El Grano de Arena,' in the first number, which appeared Feb. 15, 1896. This paper publishes with each number several columns of matter in the Nahuatl language.

The town of Tepoztlan is situated in the State of Morelos, about twelve miles northeast of Cuernavaca, the capital of the State. It is at the extreme northeastern limit of the extensive Valley of Cuernavaca, at the southwestern border of which are situated the famous ruins of Xochicalco. It may be easily reached from the City of Mexico by two routes; the first being by the Mexican, Cuernavaca and Pacific Railroad, which now terminates at Tres Marias, but will in the near future be extended to Cuernavaca. At the present time a lumbering stage-coach is used

[1] This paper was read before Section H of the A. A. A. S. at the Buffalo meeting, August, 1896.

[2] This account will appear in the Report of the Congress, now being printed by the Department of Justice and Public Instruction, of Mexico.

to traverse the distance. At Cuernavaca it is necessary to take mules for a rough ride of about twelve miles to Tepoztlan.

The other route is by the Interoceanic Railroad to Yautepec, a most picturesque ride, passing in close proximity to the base of Popocatepetl, and winding through the fertile valley of Cuautla. From Yautepec mules are taken for an ascending ride of ten or twelve miles to Tepoztlan.

By the first route the journey is through the Cuernavaca Valley; by the second, through the Cuautla Valley. Tepoztlan being located on elevated ground between rugged cliffs which divide the two valleys, commands a view of both, a most strategic site for a town, and easily defended from invaders.

This locality is in the nature of a plain inclining from west to east, protected at the north and south by bold and rugged mountains. The cliffs rising to the south of the town are less imposing and much easier to climb.

It was among the sheltered spots here that the ancients built their tombs, several of which have been found, being in the form of stone-lined cysts. The most prominent peak of this southern range is at the western end, towering high above the rest, guarding, as it were, the Cuernavaca Valley. This mountain is named Chalchihuitepetl, or hill of the Chalchihuite, the sacred green stone of ancient Mexico and Central America. There are said to be old quarries on the southern side of the mountain which have not yet been investigated.

The imposing cliffs which rise to the north of the town present the aspect of buttes, from the recesses of which break forth springs of water which unite in one stream and flow through the town, affording a never-failing source of water to the inhabitants.

It is a most picturesque spot, and formerly must have supported a large population, many aboriginal relics abounding, some of which have been gathered together and placed in a building set apart by the municipality for a museum.

The people living here are lineal descendants of the Aztecs; at no place in Mexico is the sonorous Nahuatl language spoken with greater purity, or old customs adhered to with greater tenacity, the people taking great pride in their ancestry.

The population is between five and six thousand, and although there are eight churches, only one priest presides over them all. During feast days the sounds of the old wooden drum, the Teponaztli, and the clay flute, the Chirimia, are still heard.

We have here the interesting spectacle of a town of almost pure aboriginal blood, almost unknown in the City of Mexico, and within a day's journey of the same, possessing a museum for the preservation of the antiquities of their ancestors, and publishing a paper in both Spanish and Nahuatl.

I visited the place last April in company with Mr. Rodriguez, whose services were of the greatest value, and through his assistance in securing Indians to carry my photographic instrument and refreshments, I was able to spend an entire day at the ruin. I secured photographs of the temple, but the air was so filled with smoke from burning brush, that it was impossible to take good general views of the landscape.

Description of the Temple.

On one of the most inaccessible peaks of the northern range of mountains, at a point which commands a view of the whole region, was erected the old temple. It can be barely discerned from the town, and the ascent to the summit of the peak is arduous, and in some places, dangerous.

After leaving the town, the ascent is constantly upward until the base of the cliffs is reached, upon which, nearly two thousand feet above, is the temple. We enter a long cañon, and begin the difficult part of the ascent. Climbing upward we often encounter long flights of steps, some merely cut out of the solid rock, while others are stones placed to form steps. The appearances indicate that there was once a continuous flight, but many of the steps have been washed away by the torrents of water which flow through here during the rainy season. On the vertical walls which rise on either side are several inscriptions carved in the rock.

About half the distance up the mountain we wind around the cliff and begin the most difficult part of the ascent. In some places for nearly one hundred feet the ascent is nearly vertical, steps being cut in the rock and in other places masonry being built to support the steps.

When Mr. Rodriguez began his explorations he found it necessary to place ladders in two places, as the cañon is blocked by fallen boulders.

The last three or four hundred feet are really dangerous; a false step would precipitate one to certain death. A few men at these points could successfully resist the invasion of hundreds.

Reaching the summit we find an irregular surface divided in two parts, connected by a narrow neck; upon the western one is the temple. The eastern part contains the vestiges of low walls and terraces, occupying nearly the entire area. These may be the remains of the houses of the priests, the guardians of the sacred spot. To the back rises a cliff clothed with pine trees; this cliff can only be reached from this place. Mr. Rodriguez found water here. Until last fall the temple was simply a mound in which terraces might be discerned. It rises above the base upon which the foundations were placed to the height of twenty meters, and nearly covers the entire surface of the point, which slopes sharply from the centre to the eastern end. This point is about thirty meters in length, from east to west, and nineteen meters in width.

The eastern end of the temple shows a structure composed of four parts; the lowest is simply a rude foundation built against the sloping surface of the peak. It is built of rough stones cemented together, and may have been covered with cement, but it has now entirely disappeared. This serves as a foundation for the second part, which is the foundation proper; it is in the form of a truncated pyramid, the sides rising at a vertical slant of fifteen degrees. The western surface of the peak was leveled in its construction, and the remains of its western and northern edges form a fort-like structure, which rises about two meters above the base of the pyramid.

Against the eastern side of the pyramid are the remains of a steep flight of steps which led to the top. Near the southern side, a little removed from the base, are the low walls of several chambers rising to the height of 1 meter 25 centimeters. Resting upon the lower pyramid is a smaller one of the same form, the base of which is reached by a steep flight of steps built against the western end of the lower structure.

Ascending these steps we reach the level platform and are in front of the old temple, which faced the west. In the centre of this platform are the remains of a small, square platform with serrated corners, which was once used as the sacrificial altar. The smaller pyramid served as the foundation for the building, which is reached by a steep flight of steps, twelve in number; the upper half was destroyed by the fall of the front wall of the building.

The temple is slightly smaller than the pyramid, leaving a narrow ledge on the four sides, just wide enough to walk upon. The outer walls are 1 meter 90 centimeters in thickness, composed of rubble stone strongly cemented together, and rising to the height of 2 meters 50 centimeters. Nothing remains of the front wall, with the exception of two low, square columns, showing a wide central doorway with a narrow one on either side. The temple is divided into two rooms, the outer one being 6 meters long, from north to south, and 3 meters 73 centimeters wide, from east to west. The roof had fallen in, filling the rooms with débris, but the excavations of Mr. Rodriguez revealed an almost level arch.

At either end of the front room was a narrow bench or seat, built against the wall. In the centre of the chamber Mr. Rodriguez found the remains of a raised rectangular platform, probably the place where the sacred fire was lighted, as fragments of copal and charcoal were found in the débris.

The pilasters forming the sides of the doorway leading to the inner chamber are covered with stucco, and are highly ornamented; the lower portions are decorated with a fluting, above which is seen the familiar fret found at Mitla. Above this is what appears to have been the representation of the sun symbol, the lower part only being preserved.

The doorway is 1 meter 90 centimeters wide, and the inner wall is 90 centimeters in thickness. The inner chamber is 6 meters long and 5 meters 20 centimeters wide. Running around three sides of the room is a bench faced with carved stones; this bench is 64 centimeters high and 42 centimeters wide. The upper part projects, forming a slight coping; the top was covered with cement. The coping is inscribed with chronological signs, while the lower part has four ideographs at each end. The exact number on the side of the room cannot be determined, as the bench here is somewhat destroyed. In the centre of the bench, at the back wall, Mr. Rodriguez found the remains of an altar, and two carved fragments, one painted red, the other in the shape of a crown; there, probably, was placed the idol.

The carving in this room was finely executed, and traces of the red paint, which once covered them, can still be seen. The walls were covered with a smooth cement, showing traces of red, blue, black and yellow paint. The whole structure was carefully erected, the lines of the pyramid being accurately proportioned. The work of transporting the material used must have been enormous. In the explorations potsherds, stone implements, and several small stone death's heads were found.

The most important feature of this ruin is the hieroglyphic inscription which was found in the southern side of the lower pyramid; here were discovered two stone tablets about two feet in diameter; these were removed and are now in the town. The first tablet contains the hieroglyphic representation of the mythical animal Ahuizotl or water rat; it was the sign of the Emperor Ahuizotl, the seventh Aztecan monarch, who ruled, according to Mexican chronology, from 1486 to 1502, preceding Montezuma. He was a man of energy and a bloodthirsty ruler. He extended the limits of the empire, completed the temple of Mexico, and erected many buildings. On the second slab is carved a rabbit and ten dots; this is the chronological sign, 10 Tochtli, which corresponds to 1502 of our era. This would seem to establish the date of the erection of the temple in 1502 by Ahuizotl, 17 years before the entry of Cortez into Mexico. The importance of the old temple of Tepoztlan cannot be overestimated, it being the only aboriginal structure still standing in Mexico to which we can probably assign a positive date. As it stands to-day it bears every evidence of antiquity, and one would be inclined to assign it a much greater age.

It is to be hoped that excavations may be continued at this place, which may still further bring to light material of great importance for the student of Aztecan remains.

Note.—I am under great obligations to Mr. Rodriguez, who has kindly furnished me with a copy of his plan of the Tepoztlan Temple, herewith reproduced.

Article XII.—A ROCK PAINTING OF THE THOMPSON RIVER INDIANS, BRITISH COLUMBIA.

By James Teit.

Edited, from notes of the collector, by Franz Boas.

In the interior of British Columbia numerous rock paintings are found, most of which are laid on in red ochre. Many of these have the appearance of having been made quite recently. Mr. James Teit has had the good fortune to find one near Spence's Bridge, B. C., which the Indians were able to explain in detail.

According to the custom of the Thompson River Indians, who form a branch of the Salishan family, girls on reaching maturity must retire to the hills where they undergo a long ceremony of purification and make offerings to secure good luck. At the end of this period they record their offerings and the ceremonies that they have performed on a boulder. The subjects of these records are therefore identical in many cases, and all the women of the tribe are able to interpret their meaning. Mr. Teit found a boulder of this sort near Skaitôk,[1] about one mile northeast of Spence's Bridge. It is partly imbedded in the ground and faces northward and southward. The paintings are all on the south side. The size of the boulder is about six feet square, and it rises to a height of four feet above the ground. The paintings occupy a space about 5½ feet by 4 feet in size.

The explanations were given by Waxtko,[2] an old woman living at Spence's Bridge. In giving her explanations she stated that she had made paintings of the same character when undergoing the ceremonial of purification at the time when she reached maturity, and that she was perfectly familiar with the meanings of all the designs. According to her statement the paintings were made by various girls at the time when they reached maturity. This is borne out by the appearance of the paintings, some of which are quite fresh, while others appear old and indistinct.

[1] *ô*=*o* in German *voll*.
[2] *x* aspirate guttural, like *ch* in Scotch *loch*.

In order to facilitate description I have numbered the paintings, and where it seemed desirable, separated the individual figures by broken lines.

FIG. 1.—The crossing of two trails. At such places girls used to bury part of the food they were given after having fasted four days at the beginning of the period of purification.

FIG. 2.—Crossing of trails ; see Fig. 1.

FIG. 3.—Four fir branches, such as the girl had to deposit at the entrance of her lodge, which was built of three or four fir branches. The horizontal line connecting the three branches at the left hand side indicates that they were placed near each other.

FIG. 4.—A fir branch, the needles of which have been plucked off ; used as an offering. The girls pluck the needles one by one, that their fingers may become nimble, and that they may not grow tired by the work that will be her share in life.

FIG. 5.—A girl's lodge, made of fir branches. The lower portion of the figure up to the dotted line represents fir branches that hang down from the roof of the lodge. The girl plucks the needles from these one by one. The top of the figure represents the roof of the lodge, or the fir branches placed in front of the entrance, like Fig. 3.

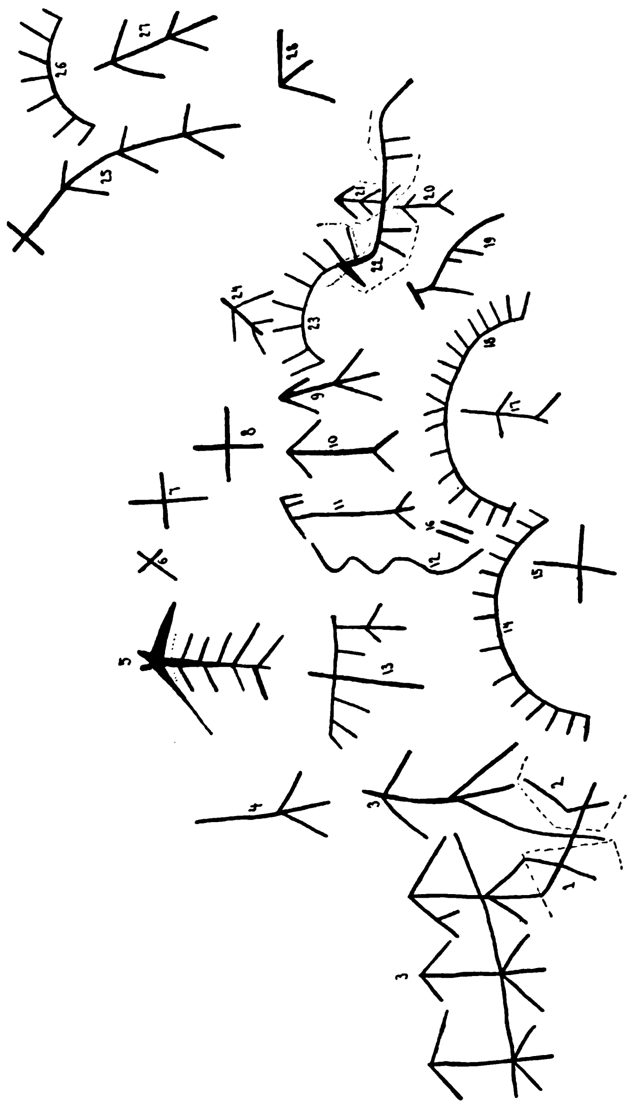
FIGS. 6, 7, 8.—Crossing of trails ; see Fig. 1.

FIG. 9.—A fir branch ; see Fig. 3.

FIG. 10.—The explainer was in doubt if this figure was a poor representation of a fir branch—it will be noticed that the short central line at the base is missing—or if it meant a trench with a fir branch at each end. Girls used to dig trenches in order to attain skill and endurance in digging roots and doing hard work of all kinds.

FIG. 11.—The cross line on top of this figure and the two downward lines to the right represent the roof of a fir lodge. The long line with the short diverging lines at its lower end represent a fir branch which is suspended from the roof of the lodge, the needles of which have been plucked off ; see Fig. 5.

FIG. 12.—A snake, which had probably formed the subject of one of the girl's dreams.



Rock Painting, Thompson River Indians, B. C.

Fig. 13.—The two long lines which cross at right angles represent the crossing of trails. The four short lines which run downward from the horizontal line represent four sticks that are placed at the crossing as an offering. The longer line to the right with its two diverging branches represents a fir branch that is also placed at the crossing.

Fig. 14.—The unfinished edge of a mat or of some other kind of basketry work. Girls had to make, during the period of isolation, small mats and baskets in order to become expert in this line of work. The painting represents work of this kind that the girl has done.

Fig. 15.—Crossing of trails; see Fig. 1.

Fig. 16.—Either two trenches (see Fig. 10), or two sticks given as an offering, or simply the numeral two (2) having reference to the snake (Fig. 12), or to another of the surrounding figures.

Fig. 17.—A fir branch; see Fig. 3.

Fig. 18.—The unfinished edge of a mat; see Fig. 14.

Fig. 19.—An animal, probably a dog, which had formed the subject of one of the girls' dreams.

Fig. 20.—A fir branch; see Fig. 3.

Fig. 21.—A fir branch; see Fig. 3.

Fig. 22.—An animal, probably a dog, which had formed the subject of one of the girls' dreams.

Fig. 23.—The unfinished edge of a mat; see Fig. 14.

Fig. 24.—A fir branch; see Fig. 3.

Fig. 25.—The upper part of this figure represents the crossing of trails. The branches farther down represent fir branches set up as offerings at the crossing.

Fig. 26.—The unfinished edge of a mat; see Fig. 14.

Fig. 27.—A fir branch; see Fig. 3.

Fig. 28.—Either a fir branch or an imperfect representation of a fir lodge.

Article XIII.—DESCRIPTION OF A NEW GENUS OF FOSSIL BRACHIOPOD FROM THE LOWER HELDERBERG LIMESTONES.

By R. P. WHITFIELD.

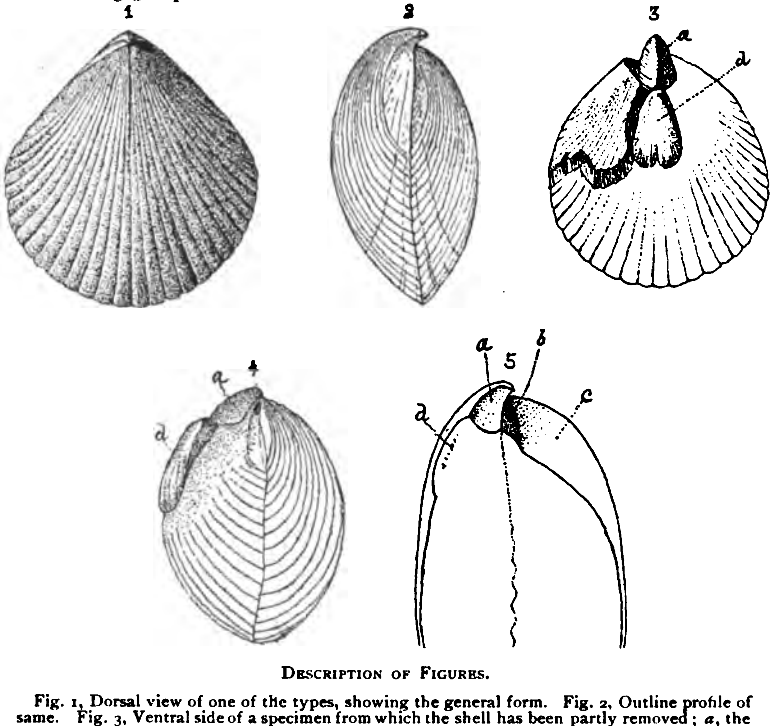
In Vol. III, Palæontology N. Y., p. 224, Prof. James Hall describes a species of Brachiopod under the name *Rhynchonella æquivalvis,* and figures it on Plate xxix. Under the description of the figures, in a footnote, he says, "This species is probably not a true RHYNCHONELLA, its surface characters and form approach RENSSELÆRIA, while in other respects it resembles RHYNCHOSPIRA." In Vol. VIII, Part II, of the same work (Introd. to the Study of the Genera of Pal. Brachiopoda), it is not mentioned.

In examining the specimens for cataloguing the types in the Museum collections, we find that it differs in some essential characters from any known genus of Brachiopods, and consequently are compelled to establish a new genus for its reception.

The shells are small, generally less than three-fourths of an inch long, broadly ovate in outline, nearly equally convex on the two sides, sometimes quite thin dorso-ventrally, but frequently quite ventricose; beaks small, not perforated; surface plicated with moderately strong radiating ribs which are convex, smooth, and entirely destitute of interspaces, the edges of the ribs being in close contact. This is a peculiar feature, and gives basis for the generic name LISSOPLEURA, by which I propose to designate it. In external features the shells much resemble a *Rhynchospira,* as remarked by Professor Hall, but there is no perforation in the beak as in that genus, neither is the beak so prominent, but small and more closely incurved. It differs also in being destitute of interspaces between the plications of the exterior. From *Rensselæria* it differs internally in the possession of a strong median septum in the dorsal valve, while in the ventral it presents almost the same features as those of that genus, namely, a narrow trough-shaped or spoon-shaped cavity in the beak, formed by the dental plates, and a rather deep but narrow muscular scar below. As yet I have not been able to ascertain what form of appendages exist in the interior, as most of the specimens in the collection are filled with opaque matter, and do not show any feature on cutting, consequently we must depend on the external features already mentioned for generic identification for the present. I think, however, that it is more than probable that it will ultimately be found to belong to the Terebratulidæ.

Lissopleura,[1] new genus.

A Brachiopodous shell, more or less inequivalve, with a small imperforate beak; surface radiately ribbed; ribs smooth, without interspaces; shell substance fibrous. Ventral valve with a spoon-shaped cavity in the beak, formed by the dental plates, and a deep bilobed muscular imprint in front of it. Dorsal valve with a strong median septum. Type, *Rhynchonella æquivalvis* Hall. Lower Helderberg group.



Description of Figures.

Fig. 1, Dorsal view of one of the types, showing the general form. Fig. 2, Outline profile of same. Fig. 3, Ventral side of a specimen from which the shell has been partly removed; *a*, the filling between the dental plates; *d*, the muscular scar. Fig. 4, Profile of the same specimen in outline. Fig. 5, View, in outline, of a specimen broken through the center so as to show the thickness of the shell, dental plates (*a*), and septum of the dorsal valve (*c*), the projecting lamellæ of the dorsal valve (*b*), and the thinning of the shell at the muscular scar (*d*) of the ventral valve. All the figures are enlarged two diameters.

[1] λισσός, smooth; πλευρά, rib.

Article XIV.—DESCRIPTIONS OF NEW NORTH AMERICAN MAMMALS.

By J. A. ALLEN.

Rangifer terrænovæ, sp. nov.

PLATES X AND XI.

Rangifer tarandus terrænovæ ALLEN, on labels attached, in May, 1896, to mounted specimens on exhibition in the American Museum of Natural History.

During the last few years the Museum has accumulated a considerable series of Caribou, from Maine, New Brunswick, Newfoundland and Greenland, numbering altogether about twenty-five specimens. A comparison of these shows that the form occurring in Newfoundland is very distinct from that of the mainland, commonly known as *Rangifer tarandus caribou* (Gmelin), and also from the Greenland form, *Rangifer tarandus grœnlandicus* (Gmelin). It may be characterized as follows:

Adult Male, Autumn Pelage.—Body above grayish brown, becoming lighter on the flanks, and passing into nearly pure white on the ventral surface; neck all round soiled white, rather purer white in front; a broad, not sharply defined eye-ring, and the whole nose and lower portion of face, including terminal portion of lower jaw, grayish white; rest of the head like the back; edges and lower surface of tail and buttocks white; front and outer surface of limbs brownish gray; feet and apical third of carpal and tarsal segments white, passing gradually into the general color of the limbs.

Adult Female.—Similar to the male in general coloration, but with rather less white.

Young of the Year.—Darker even than the adult female, with a prominent dusky lateral line and a blackish dorsal band, broadening over the shoulders.

Type, No. 11775, male ad. (mounted), Grand Lake, Newfoundland, Nov. 4, 1895; Dr. C. B. Parker.

In this form the size is large, and the antlers are especially massive, with numerous points, as shown in the accompanying illustrations (Plates X and XI).

In New Brunswick specimens, strictly comparable as to season, the body and limbs are much darker, the dark portion extending below over the anterior half of the ventral surface. The muzzle is dark, like the face, except the front of the upper lip. The white on the distal portion of the limbs is confined to a sharply-defined narrow band, about half an inch in width, bordering the hoofs, rising behind to enclose the accessory hoofs. The white eye-ring is absent. The antlers are thick and heavy for their length.

In the Greenland form there is a broad, sharply-defined white eye-ring, the front of the muzzle is white, and the hoofs are bordered by a broad, sharply-defined white line. In this form the antlers are slender, very variable in size and form, and with few points.

In three specimens of the Lapland Reindeer the white bordering the hoofs spreads indefinitely upward without sharp definition, and the upper surface of the tail is but little darker than the edges and lower surface. The antlers are large and heavy. This form has the appearance in other respects of being a quite different animal.

From the geographical isolation of the Greenland and Newfoundland forms, coupled with well-marked differences in color and other features, they may perhaps better take the rank of species than of subspecies.

I have at hand no examples of the Barren-Ground Caribou, but writers of authority, notably Baird and Caton, have contended for its specific distinctness from the Woodland Caribou, as well as the specific distinctness of both from the Reindeer of the Old World. If this view be correct, as seems to me probable, the American forms of *Rangifer* will stand as follows:

Rangifer caribou (Gmelin). Woodland Caribou.
Rangifer terrænovæ Allen. Newfoundland Caribou.
Rangifer grœnlandicus (Gmelin). Greenland Caribou.
Rangifer arcticus (Rich). Barren-Ground Caribou.

R. terrænovæ is based on a series of 6 specimens, collected at Grand Lake, Newfoundland, the first week in November, 1895, by Dr. C. B. Parker. Three of the specimens, an adult male, an adult female and young male of the year, presented by Dr. Parker, are mounted in the collection of North American Mammals, and for the last six months have been exhibited in the Museum under the name "*Rangifer tarandus terrænovæ* Allen."[1]

Reithrodontomys laceyi, sp. nov.

Lacey's Harvest Mouse.

Reithrodontomys mexicanus intermedius Allen, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 136 (in part) ; *ibid.* VIII, 1896, p. 66.

Above yellowish brown, strongly mixed with blackish, the black-tipped hairs increasing in abundance toward the median line, without, however, forming a distinct dorsal area ; generally an indistinct fulvous lateral line, varying in distinctness according to the season. Below grayish white, the fur plumbeous at base and tipped broadly with whitish. Feet dull soiled white ; ears large, thinly haired, brown externally, yellowish brown internally. Tail long, distinctly bicolor, the upper third dull brown, the rest soiled grayish white, covered with fine short hairs, which form a slight pencil at the tip.

Type, No. $\frac{12812}{10564}$, ♀ ad., Watson's Ranch, 15 miles south of San Antonio, Texas, March 6, 1896 ; H. P. Attwater.

The young adults are darker, with less fulvous.

In the new full coat the fulvous tint is stronger, the lateral line broader and brighter, and the lower surface whiter. In worn breeding pelage the tints are all paler.

Measurements.—Type specimen, ♂ ad. : total length, 156 ; tail vertebræ, 89 ; hind foot, 19 ; ear (from skin), 12.

Eleven adults range as follows :

	Length.	Tail Vertebræ.	Hind Foot.
6 ♂♂	158 (142–165)	90 (84–100)	19 (18–19.5)
5 ♀♀	152 (140–156)	85·(79– 89)	18.5 (16?–19)

This species is based on a series of 13 specimens, all practically adult, taken as follows : San Antonio, Texas, 4 males and 3 females, Feb. 28, March 19, May 12, 15 and 30, and Aug. 21, H. P. Attwater ; Turtle Creek, Kerr Co., Texas, 2 males and 4 females, Jan. 16, 17 and 28, Feb. 5 and 21, and May 30, Howard Lacey. Two of these specimens (one immature, the other in bad condition, and both without measurements) were formerly referred

[1] Since this paper was put in type, Mr. O. Bangs has described this form under the name *Rangifer terrænovæ*, in a leaflet inscribed as follows : "Actual date of distribution, Wednesday, Nov. 11, 1896, at 5 o'clock P. M." !

(l. c.) to *R. mexicanus intermedius.* The present fine series shows the impropriety of such a reference, *R. laceyi* being much smaller than either *R. m. intermedius* or *R. m. aurantius.* In coloration it resembles neither very closely.

The species is named for Mr. Howard Lacey, of Kerrville, Kerr Co., Texas, who has materially assisted Mr. Attwater in his mammalogical work.[1]

Mr. Attwater has kindly furnished the following field notes.

"These Harvest Mice are found in all parts of this (Bexar) county, except the river lowlands, where I have not yet seen them. I have seen them in the same field with *Reithrodontomys dychei.* They are generally found in the chaparral and brush regions, and in cultivated fields and orchards on the ranches. They make their nests in old woodpecker holes in fence-posts, and also in old birds' nests, such as Orchard Orioles, Verdin, etc. An Orchard Oriole's nest is sent with the nest of one of these Harvest Mice inside of it. It was taken from a peach tree in Mr. Watson's orchard on the Medina River, fifteen miles southwest of San Antonio. The mouse was seen to escape from the oriole's nest, so there can be no doubt about the species. They also construct nests of their own, a small round ball of grasses, etc., which is placed in a low thorn bush, or on the lower limb of a mesquit or huisatch tree, but more frequently among the broad leaves of the Opuntia, where they are well protected by thorns. You have some of these nests, which I sent in a previous lot. One belonged to a male, and was taken Aug. 21, 1895; the other to a female, with three young, taken Aug. 23, 1896. I have found only one full-grown mouse in each nest. Mr. Lacey has found mice-nests on cornstalks, made from corn silk, which he thinks were made by this species.

"These mice seem to be fond of peaches, eating the peach and leaving the stone hanging on the tree. Samples of the peach stones are sent which were found on the peach tree from which the oriole's nest was taken; they were on the same limb, within a few inches of the nest. They also eat weed seeds and grain, and have been caught in traps baited with oatmeal. They are not very numerous, being only occasionally met with."

[1] See this Bulletin, VIII, 1896, p. 49, and pp. 51-80, *passim.*

Perognathus mearnsi, sp. nov.

Perognathus flavus ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 58 (not of Baird).

Above intense ochraceous, conspicuously varied with black over the greater part of the dorsal area, the black diminishing on the sides, leaving a broad lateral line nearly pure ochraceous ; broad ochraceous eye-ring ; whole lower parts white ; spot behind the ear buff ; ears dusky ; tail light grayish brown, a little darker above than below.

Suckling Young.—Grayish brown varied with black ; ear-spot light buff ; eye-ring bright buff ; a narrow bright ochraceous lateral line ; below pure white ; tail darker than in adults.

Two-thirds grown young are similar, but lighter and more grayish above.

Measurements.—Male (type). Total length, 109 ; tail vertebræ, 52 ; hind foot, 14 ; ear (from skin), 4.5.

A series of 9 adult males and 7 adult females measures as follows : *Males.* Total length, 104.5 (100–109) ; tail vertebræ, 49.5 (45–53) ; hind foot, 13.7 (13–14). *Females.* Total length, 101 (95–109) ; tail vertebræ, 47 (41–53) ; hind foot, 13.8 (13–15). The ear in the dried skin ranges from 4 to 5 mm.

Skull, greatest length, 18.5 ; greatest breadth, 11.

Type, No. $\frac{11957}{10595}$, ♂ ad., Watson's Ranch, 15 miles southwest of San Antonio, Texas ; H. P. Attwater.

This form differs from true *P. flavus* in much brighter coloration, being much the most intensely colored of the *P. flavus* group, with smaller and darker ears. The mastoid area of the skull is much less expanded, and the interparietal is larger and more quadrate.

Represented by 11 adult males, 9 adult females, and 5 young of various ages. Nearly all were taken at Watson's Ranch by Mr. Attwater, at the following dates: Jan. 28, Feb. 25, March 1, 6, 7, 15, April 4, 10, 18, 20, May 18, 20, June 29, July 31, Aug. 19, Sept. 15, Oct. 11, and Nov. 20. There seems to be practically no seasonal variation in color. The young, however, are markedly different from the adults, as is the rule in the present genus.

Named for Dr. Edgar A. Mearns, U. S. A., who first called my attention to the great differences between the present species and true *P. flavus*.

Peromyscus michiganensis pallescens, subsp. nov.

Peromyscus texanus ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 64 (not of Waterhouse).

Adult.—Above grayish brown, with a slight yellowish wash, mostly confined to the sides, strongly varied with dull blackish brown, especially along the median line, often forming a distinct broad blackish dorsal band; below clear grayish white, the tips of the hairs being white and the basal portion plumbeous; ears blackish brown, narrowly edged with white; tail sharply bicolor, upper third of its circumference blackish brown, rest white; feet white, with a faint buffy tinge.

Young. — Dull gray brown (dark 'mouse-gray') above, with a darker (blackish) median band; otherwise like the adult.

Measurements.—Male (type). Total length, 127; tail vertebræ, 52; hind foot, 16; ear (from dry skin), 11.

Nine adult males measure as follows: Total length, 126 (121–130); tail vertebræ, 51 (50–52); hind foot, 16 (15–17).

A single adult female is larger than the largest male of the series

Type, No. $\frac{12818}{10666}$, ♂ ad., San Antonio, Texas, Feb. 7, 1896; H. P. Attwater.

This subspecies is based on a series of 10 adults and 7 two-thirds grown young, all winter specimens (Dec. 14–March 19), taken mostly in January and February.

They are so different in color and size from a large series of *Peromyscus michiganensis* from Fort Snelling, Minn., collected by Dr. Mearns, that they would seem to be specifically distinct, were it not that a large series of winter specimens from Lawrence, Kansas, collected by Prof. L. L. Dyche, are so nearly intermediate, in both size and coloration, as to render it probable that *P. m. pallescens* is merely a pale, depauperate form of *P. michiganensis*.

The measurements of a series of adults from each locality compare as follows:

		Total Length.	Tail Vertebræ.	Hind Foot.
Fort Snelling....	3 ♂♂,	143 (144–146)	56 (55–59)	17.3 (17–18)
"	5 ♀♀,	149 (144–153)	57 (54–63)	18.1 (18–18.5)
Lawrence.......	10 ♂♂,	137 (130–149)	51 (43–58)	17.9 (16–19)
"	5 ♀♀,	146 (137–153)	57 (55–63)	18 (16–19)
San Antonio....	9 ♂♂,	126 (121–135)	51 (50–52)	16 (14–17)

The Kansas specimens are thus good intergrades, and are almost distinct enough to merit recognition in nomenclature;

they are rather nearer the Fort Snelling series than the San Antonio series.

In coloration *P. m. pallescens* bears a close general resemblance to *Peromyscus canus* Mearns, from the same locality, but can be readily distinguished by its relatively shorter tail and hind foot and much smaller size.

Vespertilio incautus, sp. nov.

Vespertilio sp. ALLEN, Bull. Am. Mus. Nat. Hist. VIII, 1896, p. 71.

Adult in Autumn.—Above dull hair brown with a faint shade of olive, the fur becoming somewhat darker towards the base; below grayish with a faint tinge of buff, the basal half or two-thirds of the fur abruptly darker. Ears and membranes very dark or blackish brown, the posterior edge of the wing membranes distinctly lighter, especially the inner half.

Adult in Spring (March).—Lighter, both above and below, with a slight yellowish cast above.

Measurements.—Male: Expanse of wings, 282; total length, 95; tail, 45. *Female:* Expanse of wings, 275; total length, 91; tail, 38 (?). (Collector's measurements from fresh specimen.)

Male: Fore arm, 42; 1st digit, to end of claw, 7; 2d metacarpal, 35; 3d metacarp. 40, its 1st phal. 13, its 2d phal. 20; 4th metacarp. 39, its 1st phal. 12, 2d phal. 11; 5th metacarp. 39, its 1st phal. 10, 2d phal. 8; tibia, 21; foot, 15; height of ear, 13; length of tragus, 8.

The female is slightly smaller.

Skull.—Male, length, 17; greatest width of brain-case, 9.

Type, No. $\frac{12714}{10566}$, ♂ ad., San Antonio, Texas, Oct. 10, 1896; H. P. Attwater.

This species is easily distinguished by its large size and peculiar coloration, being as large or larger than *V. velifer* of Mexico, but differing from it markedly in coloration, lacking wholly the reddish brown tint of the latter.

Compared with *V. lucifugus* from Hickman, Kentucky, and Raleigh, North Carolina, it is very much larger, the average difference in the length of the fore arm, in corresponding sexes, being from 5 to 7 mm., while the skull is fully one-third more massive.

This species is based on a series of 5 specimens taken at San Antonio, Texas, by Mr. Attwater, March 12 and Oct. 10. It is a 'house' bat, all of the specimens having been taken in the house, except one, which was caught in a barn.

Vespertilio chrysonotus, sp. nov.

Ears large, black, in size and form similar to the ear in *Vespertilio evotis*. Wing membranes dark brown. Whole upper parts golden buff, the fur blackish at base, and the extreme tips lighter than the subapical zone; below pale buffy white, the fur blackish brown basally. Nose and edge of upper lip blackish, this color continued posteriorly, forming a dark line beneath the eye. Humerus, forearm, femur and tibia, whitish. The hair extends over the base of the interfemoral membrane about as in *V. evotis*.

Measurements.—Spread of wings, 230; total length, 72; length of tail, 26; hind foot, 10 (collector's measurements from the fresh specimen). Length of ear, 17; length of tragus, 10; forearm, 40; 1st digit to end of claw, 7; 2d metacarpal, 31; 3d metacarpal, 34, its 1st phalanx, 12, its 2d phal. 16; 4th metacarpal, 32, its 1st phal. 9, 2d phal. 9; 5th metacarpal, 33, its 1st phal. 9, 2d phal. 7; tibia, 18; foot, 9.

Type, No. 11645, ♀ ad., Kinney Ranch, Wyoming, July 21, 1895; W. W. Granger.

This species is based on a single specimen, which unfortunately lacks the skull. It differs from Dulzura (California) specimens of *V. evotis* in its golden-buff color, much longer fore arm, and much shorter tail. It evidently belongs to the *V. evotis* group, of which further material may show it to be merely a well-marked subspecies.

DESCRIPTION OF PLATES.

PLATE X.—Head of *Rangifer terrænovæ*, ♂ ad., from photograph of a mounted specimen, owned by Dr. C. B. Parker.

PLATE XI.—Fig. 1, antler of *R. terrænovæ*, ♂ ad.; Fig. 2, antler of *R. terrænovæ*, ♀ ad.

Fig. 3.—Antler of *Rangifer grœnlandicus*, ♂ ad.; Fig. 4, antler of *R. grœnlandicus*, ♀ ad.

FIG. 6.—Antler of *Rangifer tarandus*, ♂ ad.

The antlers are all photographed to the same scale, and are all from specimens in the American Museum of Natural History.

Article XV.—LIST OF MAMMALS COLLECTED BY MR. WALTER W. GRANGER, IN NEW MEXICO, UTAH, WYOMING AND NEBRASKA, 1895–96, WITH FIELD NOTES BY THE COLLECTOR.

By J. A. ALLEN.

During the seasons of 1895 and 1896 Mr. Granger was again associated (see this Bulletin, VII, p. 259) with the Museum Palæontological Expedition as a field assistant under Dr. J. L. Wortman, and was able to devote considerable time, especially during the season of 1895, to collecting the smaller mammals of the regions visited. The collections thus made number 500 specimens, representing 48 species and subspecies, several of which proved to be new to science and have been already described.[1] Although the collections were made at a number of widely separated localities, it seems best to present the general results under one title, with nominal lists of the species obtained at the principal points where collections were obtained.

The following general account of these localities is kindly furnished by Mr. Granger, to whom I am also indebted for field notes on many of the species.

"*Uncompahgre Indian Reservation, Utah.*—Altitude about 5000 feet. Consists for the most part of sandy bad-land country, rather thinly grassed, with a dense growth of 'grease-wood' and 'sage brush.' Both the White and Green Rivers pass through the Reservation, and are well wooded along the bottoms. A species of *Peromyscus* and a small species of *Tamias* [*T. minimus consobrinus*] were obtained along these rivers, but all the other specimens were collected in a large bad-land basin, ten miles west of the Colorado line, known as Kennedy's Hole."

[1] *Neotoma cinnamomea*, *Tamias wortmani* and *Spermophilus tridecemlineatus parvus*. See this Bulletin, VII, pp. 331, 335, 337.

Collections were made here from March 17 to June 4, 1895 (72 specimens), and include the following species:

Lepus nuttalli,	Cynomys leucurus,
Thomomys clusius,	Spermophilus 13-lineatus parvus,
Perodipus longipes,	Tamias wortmani,
Neotoma cinnamomea,	Tamias leucurus,
Peromyscus auripectus,	Tamias minimus consobrinus,
Peromyscus texanus nebrascensis,	Canis latrans.

"*Diamond Mountain, Utah.*—Altitude, 7000 feet. Country well grassed and watered, but very open. The only trees are a few scattered pines and aspens, confined to the higher ridges. The few specimens obtained here were taken at Pot Creek, which runs into Lodera Cañon, fifteen miles distant."

The only species collected here was *Peromyscus texanus arcticus.*

"*Brown's Park, Utah.*—Altitude about 7000 feet. The only specimens secured here were taken in a rocky cañon along Green River, fifteen miles above the head of Lodera."

Three specimens were obtained, one of which is referable to *Peromyscus truei*, and the others to *P. texanus nebrascensis.*

"*Kinney Ranch, Sweetwater Co., Wyoming.*—Altitude, 7500 to 8000 feet; 25 miles south of Bitter Creek station, on the Union Pacific Railway. Exceedingly dry, sandy and barren; grease-wood and sage-brush grow thickly in certain localities. The country consists mostly of rough, rocky bad-lands, and long stretches of sandy, sage-covered alkali plains. In the immediate vicinity of Kinney Ranch is an alkaline marsh of some hundred acres or so in extent. This, aside from two or three other springs and a few water holes, is the only water found within fifteen miles of the ranch. The only mammal found in the marsh and not elsewhere was a species of *Microtus.*"

Collections were made here from June 7 to August 15, 1895; the 304 specimens taken represent the following 15 species:

Lepus campestris,	Microtus, sp. inc.,
Lepus nuttalli,	Spermophilus elegans,
Thomomys clusius,	Sperm. 13-lineatus parvus,
Perognathus fasciatus,	Tamias wortmani,
Neotoma cinnamomea,	Tamias minimus consobrinus,
Onychomys leucogaster brevicauda,	Vespertilio ciliolabrum,
Peromyscus texanus nebrascensis,	Vespertilio chrysonotus.
Microtus pallidus,	

"*Rife's Ranch, Utah.*—Altitude, 8000 feet ; 20 miles south of Kinney Ranch. The country is practically the same as at Kinney Ranch."

During the single day's collecting here only *Spermophilus elegans* and *Onychomys leucogaster brevicauda* were taken.

"*Snake River, Colorado.*—Altitude, 7000 feet. This locality is 40 miles east of Kinney Ranch, at what is known as Cherokee Crossing of Snake River, 25 miles down the river from Bagg's post office. The river bottom is quite well wooded in places, and overgrown with brush. Otherwise the locality is much like the country at Kinney Ranch."

The only species taken here, during a short halt, was *Neotoma cinnamomea*.

"*Three Forks, Colorado.*—Altitude, 9000 to 9500 feet. This locality is 30 miles above Bagg's post office, on Snake River, in the lower edge of the pine belt. The river valley is thickly grown with deciduous trees. The specimens were taken near the river."

This locality is evidently on the edge of a fauna very distinct from that of the lower open country immediately to the westward. The 26 specimens taken during a day's stay at this camp represent the following species: *Tamias lateralis* (in place of *T. wortmani*), *Tamias quadrivittatus* (in place of *T. consobrinus*), *Neotoma orolestes* (in place of *N. cinnamomea*), and *Peromyscus texanus arcticus* (in place of *P. t. nebrascensis*). Also one specimen of *Onychomys leucogaster brevicauda* was taken.

Elk Mountain, Wyoming.—The five specimens collected at this camp represent *Neotoma orolestes* and *Peromyscus texanus articus*, and were taken on the overland stage trail at the base of the mountain, just at the edge of the pine belt.

"*Sherman, Wyoming.*—Altitude, 8900 feet. On the overland stage trail, 9 miles north of Sherman station, on the Union Pacific Railway. The specimens were taken in a grove of pines and spruces, except those of *Zapus* and *Microtus*, which were from a cultivated field in a clearing."

The 33 specimens taken here represent the following species:

Lepus grangeri,	Peromyscus texanus arcticus,
Zapus, sp. inc.,	Tamias quadrivittatus,
Microtus longicauda ?	Sciurus hudsonicus,
Microtus, sp. inc.,	Sorex personatus.
Neotoma orolestes,	

"*Perch and Bassett, Rock Co., Nebraska.*—These localities are in the typical Nebraska sand hills. The specimens of *Microtus, Sorex* and *Blarina* were taken at a large marshy lake, near Perch post office."

The 132 specimens, collected Oct. 6–27, 1895, represent 12 species, as follows:

Perodipus longipes,	Peromyscus texanus nebrascensis,
Perognathus fasciatus flavescens,	Spermophilus obsoletus,
Microtus pennsylvanicus,	Spermophilus 13-lineatus pallidus,
Microtus austerus,	Scalops argentatus,
Onychomys leucogaster,	Blarina brevicauda,
Reithrodontomys dychei,	Sorex personatus haydeni.

"*Chaco Cañon, New Mexico.*—Very dry and sandy 'greasewood country,' with a few cedars on the higher ridges. The specimens were taken in the cañons, about 20 miles east of the Navajo Reservation."

The 34 specimens taken here (June 11–26, 1896) represent a fauna allied to that of the Uncompahgre Indian Reservation, Utah, the following species being represented:

Lepus arizonæ,	Peromyscus auripectus,
Perodipus longipes,	Peromyscus rufinus,
Neotoma cinnamomea,	Tamias leucurus.
Onychomys leucogaster brevicauda,	

Besides the above, the collection contains 8 specimens from Spring Creek, Nebraska (see this Bulletin, VII, p. 261), among which are 4 specimens of *Microtus haydenii.*

1. **Lepus campestris** *Bach.* PRAIRIE HARE.—One specimen, a half-grown male, taken at Kinney Ranch, July 15.

"Quite common in the vicinity of Kinney Ranch. Three specimens were seen on the Uncompahgre Indian Reservation, but none were met with in the intervening country, it being too mountainous."—W. W. G.

2. **Lepus arizonæ** *Allen.* ARIZONA COTTONTAIL.—A series of 5 specimens, from Chaco Cañon, northwestern New Mexico (head of San Juan basin), collected June 15–17, are referred to *L. arizonæ.*

3. **Lepus nuttalli** (*Aud. & Bach.*). SAGE HARE; SAGE COTTONTAIL.—A series of 7 adults from the Uncompahgre Indian Reservation, Utah (March 17–20 and May 4–6), and another series of 11 adults and 5 young (one-fourth to one-half grown) from Kinney Ranch, southwestern Wyoming (June 17–Aug. 1) seem nearly indistinguishable from another series from the Bad-lands (Corral Draw and vicinity) of South Dakota (May, July and August), previously recorded (this Bulletin, VII, p. 264) as *Lepus sylvaticus nuttalli.* They all have the long ears and greatly inflated audital bullæ of the *L. arizonæ* group, but are paler and of a more yellowish cast than true *L. arizonæ*, or than either of its subspecies (*minor* and *major*) lately recognized by Dr. Mearns (Proc. U. S. Nat. Mus., XVIII, 1896, p. 557). In general size, however, the Utah, Wyoming and South Dakota specimens are larger, and differ in coloration from *L. arizonæ* from the desert region of the Lower Colorado River in southeastern California, lacking the rufous tint of *arizonæ*, which is replaced by a very pale yellowish tint, shown even in the nape patch and legs. They also have the ears much more heavily clothed.

These specimens are provisionally referred to *Lepus nuttalli*, in the absence of material from the type locality of the latter for comparison.

The adults of the three series measure as follows:

	Length.	Tail Vertebræ.	Hind Foot.	Ear from notch.
Uncompahgre, 1 ♂ ...	400	45	95	64
" 6 ♀ ♀ ..	403 (386–420)	45 (40–55)	102 (100–110)	66 (61–67)
Kinney Ranch, 6 ♂ ♂ ..	361 (335–380)	51 (49–55)	90 (85– 92)	55.3 (51–60)
" 5 ♀ ♀ ..	410 (404–418)	46 (40–54)	96 (92–101)	63 (61–65)
South Dakota, 2 ♂ ♂ ..	372 (305–406)	58 (44–71)	92 (89– 95)	56 (53–59)
" 3 ♀ ♀ ..	397 (371–419)	58 (51–63)	92 (89– 95)	59 (55–60)

As usual in the Hares, the females exceed the males in size.

"Common at both Kinney Ranch and the Uncompahgre Indian Reservation. I have never seen Cottontails so abundant as at Kinney Ranch. On the Uncompahgre Reservation they were confined to the rocks in spring while the snow remained, but later they were common enough in old burrows of Prairie Dogs and Badgers."—W. W. G.

4. **Lepus grangeri** *Allen.* GRANGER'S COTTONTAIL.—One specimen, ♂ ad., Sherman, Wyoming, Sept. 9. This example agrees well with the Black Hills form named by me *Lepus sylvaticus grangeri.* A further comparison with large series of the *L. sylvaticus* and *L. arizonæ* groups from various localities seems to show that *grangeri* is not intimately related to any other described form.

5. **Erethizon epizanthus** (*Brandt*). YELLOW-HAIRED PORCUPINE.—One specimen, skeleton, from Lost Cabin, Wyoming, Aug. 25.

"Three or four were seen at this locality. They frequent the vicinity of bad-lands, where they live in caves. To the north of Chaco Cañon, New Mexico, it was very common. In this locality nearly every piñon tree had had the bark eaten off from the upper limbs by these animals."—W. W. G.

6. **Thomomys clusius** *Coues.*—Two specimens, Uncompahgre Reservation (April 3 and May 3), both males; one is adult, the other slightly immature. They measure, respectively, total length, 193, 175; tail vertebræ, 58, 44; hind foot, 25, 23. Also 2 specimens, not fully grown, Kinney Ranch, July 21 and 23.

"Rather rare on the Uncompahgre Reservation, but fairly common at Kinney Ranch, where it inhabited the sandy stretches."—W. W. G.

7. **Perodipus longipes** (*Merriam*). MOKI KANGAROO RAT. —Represented by 23 specimens from the Uncompahgre Indian Reservation, Utah (collected March 20–May 5); 17 specimens from Kinney Ranch, Wyoming (July 25–Aug. 7); 15 specimens from Rock County, Nebraska (Oct. 8–22), and 3 specimens from Chaco Cañon, New Mexico (June 16).

I am surprised to find that the Nebraska specimens present no tangible differences from those from Utah and Wyoming; they differ decidedly, however, in much paler coloration from a large series of *Perodipus richardsoni* from Beaver County, Oklahoma (Oct. 12-26). The latter is probably merely a subspecies of *P. longipes*, which is the earlier name for the group.

Throwing out a few obviously immature specimens, the measurements are as folllows :

	Total Length.	Tail Vertebræ.	Hind Foot.
Utah........11 ♂♂,	256 (243–275)	143 (139–151)	41 5 (39–43)
" .... 8 ♀♀,	254 (235–271)	141 (130–144)	41.3 (40–42)
Wyoming.... 6 ♂♂,	258 (235–278)	144 (138–159)	42 (40–44)
" ... 4 ♀♀,	255 (243–272)	146 (138–160)	41.5 (39–43)
Nebraska....10 ♂♂,	253 (240–272)	145 (134–158)	42 (41–43)
" ....3 ♀♀,	253 (240–261)	139 (135–142)	41.7 (41–42)

A small series from Custer County, South Dakota, previously referred to *P. richardsoni* (this Bulletin, VII, p. 265), evidently belong to the *longipes* type.

"Common throughout the Uncompahgre Reservation. At Kinney Ranch I found them only in the sand dunes, and associated with *Spermophilus parvus*."—W. W. G.

8. **Perognathus fasciatus** (*Wied*). MAXIMILIAN'S POCKET MOUSE.—Two specimens, ♂ and ♀, full grown but rather young, collected at Kinney Ranch, Wyoming, July 21 and 23, I am unable to distinguish subspecifically from Montana and South Dakota (eastern base of the Black Hills) examples of *P. fasciatus*. This extends the range of the *P. fasciatus* group far to the west of previously reported localities, and into the Green River basin.

These specimens measure: Total length, ♂ 126, ♀ 134; tail vertebræ, ♂ 68, ♀ 69; hind foot, ♂ 19, ♀ 18.

"Taken in the sand hills, and the only ones seen, although I trapped especially for them."—W. W. G.

9. **Perognathus fasciatus flavescens** *Merriam*. NEBRASKA POCKET MOUSE.—Represented by 8 full-grown specimens from Perch, and 2 from Basset, Rock Co., Nebr., collected Oct. 3–27. The 6 males measure: Total length, 122 (115–127); tail vertebræ, 61 (58–64); hind foot, 17 (16–18). The four

females are slightly smaller, measuring: Total length, 121 (117–125); tail vertebræ, 58 (57–59); hind foot, 16.5 (15–17).

10. **Zapus**, sp. inc. Jumping Mouse.—One specimen, ♀, Sherman, Wyoming, Sept. 10. Length, 211; tail vertebræ, 125; hind foot, 29.

This specimen is very unlike any described form of this genus, and differs from any specimens I have seen from any other locality, in having the sides of the body very light yellowish, in very strong contrast with the nearly black dorsal area.

11. **Microtus (Lagurus[1]) pauperrimus** *Cooper*. Pallid Meadow Mouse.—Two specimens, collected at Kinney Ranch, July 23 and 24, seem referable here, agreeing closely with Dr. Merriam's description (N. Am. Fauna, No. 5, July, 1891, p. 64) of examples from the Salmon River Mountains, Idaho. These specimens measure respectively as follows: No. $\frac{11137}{9431}$, ♂ ad., total length, 118; tail vertebræ, 24; hind foot, 16. No. $\frac{11138}{9432}$, ♀ ad., total length, 108; tail vertebræ, 24; hind foot, 16.

"The two specimens were taken from the same burrow in a sand hill near Kinney Ranch."—W. W. G.

12. **Microtus (Pedomys) haydenii** (*Baird*). Hayden's Meadow Mouse.—Four specimens, 3 adult males, 1 adult female, Spring Creek, Custer Co., South Dakota, June 12, Nov. 12 and Dec. 12. Although taken at different seasons, they all agree closely in coloration. They also agree with the single specimen previously recorded (this Bulletin, VI, 328) from the same locality. They measure as follows: Total length, 153 (132–164), tail vertebræ, 33 (27–37); hind foot, 20 (19–21).

13. **Microtus (Pedomys) austerus** (*Le Conte*). Prairie Meadow Mouse.—Represented by 7 specimens from Perch, Rock Co., Nebraska, Oct. 26–28. The five adults (3 ♂♂, 2 ♀♀) measure as follows: Total length, 141 (135–154); tail vertebræ, 33 (31–35); hind foot, 20 (19–20.5).

"All were taken in dry sandy ground bordering a cornfield. It was common at that particular locality."—W. W. G.

[1] *Cf.* Merriam, Am. Nat., XXIX, p. 758, Aug., 1895.

14. Microtus (Microtus) pennsylvanicus (*Ord*). EASTERN MEADOW MOUSE.—A series of 19 specimens, from Perch, Nebraska, Oct. 5–20, do not differ appreciably from *M. pennsylvanicus* from the East. Of 19 specimens, 15 are in adult pelage, though doubtless not all fully adult in size. They measure as follows:

	Length.	Tail Vertebræ.	Hind Foot.
7 ♂ ♂	153 (138–161)	41 (34–48)	21 (20–22)
8 ♀ ♀	154 (140–179)	38 (35–49)	21 (20–22)

15. Microtus (Microtus) longicauda? (*Merriam*). LONG-TAILED MEADOW MOUSE.—Two specimens from Sherman, Wyoming, Sept. 11, are doubtfully referred to this species. One is a young adult, the other an old adult, with the tail mutilated.

16. Microtus (Microtus), sp. inc.—The 12 specimens included under the above heading are from the following localities: Sherman, Wyoming, Sept. 10 and 11, 3 specimens; Laramie, Wyoming, Sept. 8, 5 specimens; Kinney Ranch, Wyoming, July 10–Aug. 15, 4 specimens. All but 4 are more or less immature, some being quite young. The 4 adults (3 ♀♀, 1 ♂) measure as follows: Total length, 139 (131–146); tail vertebræ, 36.5 (33–40); hind foot, 18.5 (17–20).

"The specimens from Kinney Ranch were all taken in the alkali marsh previously mentioned, and so were rather rare at this locality"—W. W. G.

17. Neotoma cinnamomea *Allen*. FULVOUS WOOD RAT.

Neotoma cinnamomea ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 331. (Separates published Nov. 8, 1895.)

As already stated (l. c.), this species is represented by 31 specimens from Kinney Ranch, Wyoming, taken July 6–Aug. 6; and 2 from Uncompahgre Indian Reservation, Utah, April 2 and 9. To the same species I refer 3 specimens since received from Chaco Cañon, northwestern New Mexico, collected June 18–23, 1896.

This species proves to be very different from *N. rupicola* of the Bad-lands of South Dakota, differing in important cranial characters, as well as in size, though the two forms bear a very close resemblance to each other externally. It is also very different from *N. orolestes.*

"Found throughout the Washakie bad-lands and Uinta Basin, wherever the country is rough enough to suit their habits, which are the same as those of *N. rupicola*" (see this Bulletin, VII, p. 270).—W. W. G.

18. Neotoma rupicola *Allen.* BAD-LANDS RAT.—Three specimens, Spring Creek, South Dakota, Dec. 17 and Feb. 17 and 19. These, though in winter pelage, differ very little from September specimens, except that the pelage is fuller.

19. Neotoma orolestes *Merriam.* MOUNTAIN WOOD RAT.—I refer provisionally to this species 1 specimen from Elk Mountain, Wyoming (Sept. 7); 5 from Sherman, Wyoming (Sept. 9, 10); 4 from Snake River, northwestern Colorado (Aug. 25, 26); and 2 from Three Forks, northwestern Colorado (Sept. 2). They agree in much larger size, larger amount of black in the dorsal pelage, and grayer nose, in comparison with *N. cinnamomea*, and in these features they approach *N. orolestes*, described from a little further south in the mountains of Colorado (type locality of the species, Saguache Valley). While resembling this species in color, they average rather smaller than the measurements given for the type of the species. The 10 adults from the localities above named measure as follows:

	Length.	Tail Vertebræ.	Hind Foot.
6 ♂♂	392 (382–394)	167 (158–182)	43 (40–45)
4 ♀♀	357 (344–365)	154 (147–160)	41 (40–41)

The corresponding measurements for the same number of examples of *N. cinnamomea* are as follows:

	Length.	Tail Vertebræ.	Hind Foot.
6 ♂♂	364 (356–368)	158 (151–163)	41 (40–43)
4 ♀♀	343 (337–351)	148 (144–150)	39 (37–41)

"Apparently a common animal at the localities where specimens were taken."—W. W. G.

20. Peromyscus truei (*Shufeldt*). TRUE'S CLIFF MOUSE.—One specimen, ♀ adult, Brown's Park, northeastern Utah, June 15. Apparently identical with specimens from near the type locality in New Mexico.

"Taken from a nest of *Neotoma cinnamomea*, in a high cliff."—W. W. G.

21. Peromyscus auripectus *Allen*. SILKY CLIFF MOUSE.—Uncompahgre Indian Reservation, April 2 and 3 and May 10; 4 specimens, all adult. They are nearly indistinguishable in coloration and size from the type series of the species from Bluff City, southeastern Utah (May 8–17). Three of the four specimens have the fulvous pectoral spot strongly developed.

Chaco Cañon, San Juan region, northwestern New Mexico, June 7 and 8; 4 specimens, all adult males. These all lack the fulvous pectoral spot, but are otherwise like the Bluff City series in coloration, though slightly larger.

In measurements these three series compare as follows:

		Length.	Tail Vertebræ.	Hind Foot.
Bluff City	5 ♂♂, 5 ♀♀	171 (167–181)	92 (85–98)	22.3 (22–24)
Chaco Cañon	4 ♂♂	175 (171–180)	92 (90–95)	22.1 (22–23)
Uncom. Ind. Res.	4	167 (159–176)	89 (86–92)	22.2 (22–23)

"Relatively much less common than the other species of *Peromyscus* which were found associated with it, the ratio, as determined by trapping, being about as 1 to 5. I have always found it confined to rocky places. In Chaco Cañon the Pueblo ruins were its favorite abode."—W. W. G.

22. Peromyscus texanus nebrascensis (*Mearns*). FULVOUS WHITE-FOOTED MOUSE.—This species is represented by a large number of specimens, from a wide range of localities, as follows: Uncompahgre Indian Reservation, Utah, May 1–June 1; 11 specimens, 8 adult and 5 young. Kinney Ranch, Wyoming, June 15–Aug. 5; 60 specimens, about one-half adult. Perch, Rock Co., Nebraska, Oct. 7–24; 14 specimens, 6 adult.

The Nebraska specimens have smaller ears than those from Utah and Wyoming, and are much brighter colored, but the color differences may be in part due to season. The series, however, is too small for satisfactory comparison. The adults of these series measure as follows:

		Length.	Tail Vertebræ.	Hind Foot.
Uncom. I. Res.	4 ♂♂,	149 (142–160)	63 (59–70)	19.8 (19–20)
" " ..	2 ♂♂,	165 (159–170)	70 (60–75)	21 (20–22)
Kinney Ranch..	8 ♂♂,	159 (147–172)	71 (65–74)	19 (19–21)
" " ..	16 ♀♀,	159 (154–173)	76 (66–78)	19.8 (19–20)
Perch, Nebr....	1 ♂,	161	65	19
" " ...	2 ♀,	160 (156–165)	62 (61–63)	19 (19–19)

23. **Peromyscus texanus arcticus** (*Mearns*). NORTHERN WHITE-FOOTED MOUSE.—To this form are referred 3 immature specimens from Diamond Mountain, Utah, June 15; 8 specimens (all adult) from Three Forks, northwestern Colorado, Sept. 2; 5 specimens (adult) from Fort Steele, Wyoming, Sept. 2; 4 specimens (all nearly adult) from Elk Mountain, Wyoming, Sept. 7; 5 specimens (young adults) from Sherman, Wyoming, Oct. 10. They are not quite typical, but belong here rather than elsewhere. As they are nearly all young adults, it is hardly worth while to give the measurements.

24. **Peromyscus rufinus** *Merriam.*—A series of 13 specimens, all but 3 fully adult, from Chaco Cañon, northwestern New Mexico (June 11–22). They are the same as the Rowley series from practically the same locality, recorded first as *Sitomys sonoriensis* (this Bulletin, V, 1893, p. 74), and later (this Bulletin, VII, 1895, pp. 232–234) as *Peromyscus leucopus rufinus.* For comparison with the measurements already published (l. c., p. 234) the following may be added: 4 ♂♂, 6 ♀♀ = 10; length, 161 (150–173); tail vertebræ, 67 (63–77); hind foot, 19.7 (19–20).

"The Puerco ruins in Chaco Cañon, near our camp, were overrun with these mice. I have never seen any species of mouse so abundant at any other locality. They were associated with *P. auripectus.*"—W. W. G.

25. **Reithrodontomys dychei** *Allen.* DYCHE'S HARVEST MOUSE.—A series of 23 specimens of *Reithrodontomys*, ranging in age from nursing young to adults, from Perch, Rock Co., Nebr., (Oct. 3–26), seem better referable to *R. dychei* than to the more western *R. dychei nebrascensis.*

"Very common, and found in all sorts of locations. I found nests of this species containing nursing young as late as Oct. 29." —W. W. G.

26. Onychomys leucogaster (*Wied*). EASTERN GRASSHOPPER MOUSE.—Represented by 20 specimens from Perch, Rock Co., Nebraska, collected Oct. 3–25. All but three or four appear to be fully adult. The measurements are:

	Length.	Tail Vertebræ.	Hind Foot.
8 ♂ ♂	141 (139–148)	39 (36–41)	20.6 (20–21)
8 ♀ ♀	142 (135–146)	39.4 (36–45)	21 (20–22)

"A common mouse at Perch, where it was especially abundant in old fields."—W. W. G.

27. Onychomys leucogaster brevicauda *Merriam*. IDAHO GRASSHOPPER MOUSE.—A series of 22 specimens, all but 6 more or less immature (many are little more than half grown), is provisionally referred to this species. All but three were taken at Kinney Ranch, June 29 to Aug. 5—the others at Rife's Ranch, June 17. A specimen from Three Forks, northwestern Colorado, collected Sept. 1, is referred also to the same form. Also two examples from Chaco Cañon, northwestern New Mexico, taken June 16.

The chief difference between the above-mentioned specimens and typical *O. leucogaster* consists in their very noticeably larger ears.

Three adult males and 4 adult females from Kinney Ranch measure as follows:

	Length.	Tail Vertebræ.	Hind Foot.
3 ♂ ♂	136 (132–143)	37 (35–40)	20 (19–21)
4 ♀ ♀	132 (120–141)	37 (32–38)	20 (19–20)

Another specimen, in the same lot, but not included in the foregoing measurements, has a much longer tail, measuring as follows: Length, 146; tail vertebræ, 50; hind foot, 20.

"Very common at Kinney Ranch, and found in the same burrows with *Spermophilus elegans*. At Three Forks, Colorado, the single specimen taken was the only one seen, the locality apparently being not suited to the needs of this species."—W. W. G.

28. Cynomys leucurus *Merriam.* White-tailed Prairie Dog.—One specimen, Uncompahgre Indian Reservation, ♀ ad., April 28.

"Quite common at Kinney Ranch and Uncompahgre Reservation. I also observed colonies at Baggs, Rawlins, Fort Steele, and Laramie City, Wyoming.

"The first examples of *Cynomys ludovicianus* met with on our wagon journey east were seen at the base of the Laramie Mountains, 25 miles west of Cheyenne."—W. W. G.

29. Spermophilus elegans *Kennicott.* Wyoming Spermophile.—A series of 35 specimens from Kinney Ranch, Bitter Creek, Wyoming, June 17–July 12, consists largely of immature examples, varying in age from less than one-quarter grown to nearly full size. The unquestionably adults of the series measure as follows:

	Total Length.	Tail Vertebræ.	Hind Foot.
7 ♂ ♂	270 (251–283)	69 (67–76)	41 (39–42)
6 ♀ ♀	268 (256–277)	68 (64–74)	40 (40–41)

"First observed at Brown Park. It is an exceedingly abundant animal, and a nuisance where any attempt at farming is made. It evidently retires to its burrows very early in the season, as I did not see a single individual after the 20th of August."—W. W. G.

30. Spermophilus obsoletus *Kennicott.* Kennicott's Spermophile.—One specimen, ♂ ad., from Perch, Rock Co., Nebraska, Oct. 6.

"This was the only individual seen, and I was informed by residents at Perch that it was rare in this locality."—W. W. G.

31. Spermophilus tridecemlineatus pallidus *Allen.* Pale Striped Spermophile.—One specimen, ♂ ad., Perch, Rock Co., Nebraska, Oct. 6, 1895.

32. Spermophilus tridecemlineatus parvus *Allen.* Small Striped Spermophile.

Spermophilus tridecemlineatus parvus Allen, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 337 (Separates published Nov. 8, 1895).

Represented by 2 specimens from the Uncompahgre Indian Reservation, Utah, and 9 from Kinney Ranch, Wyoming, as already recorded (l. c.).

"This species was restricted to the sand dunes in a bad-land basin near Kinney Ranch, and to a similar locality in Kennedy's Hole."—W. W. G.

33. Tamias wortmani *Allen.* WORTMAN'S CHIPMUNK.

Tamias wortmani ALLEN, Bull. Am. Mus. Nat. Hist. VII, 1895, p. 335 (Separates published Nov. 8, 1895).

As previously recorded (l. c), this species is represented by a series of 58 specimens, collected at Kinney Ranch, Wyoming.

"Common throughout the Washakie bad-lands, but not generally distributed, being confined to rough and rocky places."—W. W. G.

34. Tamias lateralis (*Say*). SAY'S CHIPMUNK.—One specimen, ♀ ad., Three Forks, northwestern Colorado, Sept. 1. This is a quite typical example of the species.

35. Tamias leucurus *Merriam.* ANTELOPE CHIPMUNK.—Represented by 11 specimens, collected in the Uncompahgre Indian Reservation in Utah, March 17–May 19, mostly in worn breeding pelage. They seem quite indistinguishable from topotypes of this species, collected at corresponding seasons. They consequently differ markedly from a perfectly comparable series of *T. l. cinnamomeus* from the San Juan region of southeastern Utah, to which they would seem, on geographical grounds, more nearly allied. They measure as follows :

	Total Length.	Tail Vertebræ.	Hind Foot.
6 ♂ ♂	213 (203–221)	60 (50–68)	39.8 (38–42)
4 ♀ ♀	216 (205–232)	64 (62–68)	39 (35–40)

Four specimens from Chaco Cañon, New Mexico, June 17 and 18, are also referred to this form.

"Common on the Uncompahgre Reservation, and one of the most conspicuous animals at Chaco Cañon, New Mexico. I observed them from the Rio Puerco westward to the Navajo Reservation."—W. W. G.

36. Tamias minimus consobrinus *Allen.* WAHSATCH CHIPMUNK.—Represented by 46 specimens, all collected at Kinney Ranch, Wyoming, June 7–Aug. 8. Many of the July specimens were in molt when taken, portions of the old breeding pelage being mixed with the new coat. Most of the July and August specimens had completed the molt. The adults, before molting, become very much faded and worn, losing nearly all of the bright tints that characterize the post-breeding pelage. The males, as usual in this and allied genera, molt considerably earlier than the females. The adults of the series measure as follows:

	Total Length.	Tail Vertebræ.	Hind Foot.
14 ♂ ♂	186 (176–194)	86 (77–93)	29.3 (27–31)
22 ♀ ♀	191 (176–195)	86 (79–93)	29.5 (27–30)

"Common throughout the entire Washakie bad-lands. Occurs with *T. wortmani*, but the latter is not so generally distributed."—W. W. G.

37. Tamias quadrivittatus (*Say*). COLORADO CHIPMUNK.—A series of 11 specimens, collected at Sherman, Wyoming, Sept. 9–11, are distinctly referable to this form of the *quadrivittatus* group. They measure as follows:

	Total Length.	Tail Vertebræ.	Hind Foot.
5 ♂ ♂	192 (186–195)	84 (78–90)	32 (31–34)
6 ♀ ♀	194 (191–197)	84 (78–89)	31.7 (30–33)

A series of 16 specimens from Three Forks, northwestern Colorado (30 miles above Bagg's Crossing), collected Sept. 1–2, are also referred to *T. quadrivittatus*, although not typical. They are a little larger, with a slightly smaller hind foot, considerably darker in color, and have a much narrower, slenderer tail. The dark stripes are blacker, and the median light stripes grayer (less white), and the sides are duller rufous than in true *T. quadrivittatus*. The differences, however, are hardly enough pronounced to render their recognition in nomenclature desirable. This series measures as follows:

	Total Length.	Tail Vertebræ.	Hind Foot.
10 ♂ ♂	190 (188–195)	85 (81–89)	29.5 (28–30)
5 ♀ ♀	198 (188–204)	88 (84–93)	30.7 (30–31)

"An exceedingly common Chipmunk at both Sherman and Three Forks."—W. W. G.

38. **Sciurus hudsonicus** (*Erxl.*). CHICKAREE.—Three specimens from Sherman, Wyoming, collected Sept. 9–11, represent a pale phase of *S. hudsonicus*, not, however, sufficiently different from the eastern type to be separable as a subspecies. In some features the specimens grade slightly toward *S. h. richardsoni*.

39. **Vespertilio ciliolabrum** *Merriam*. LITTLE PALE BAT.—Two specimens, males, Kinney Ranch, Wyoming, Aug. 1 and 3.

"Small bats were fairly abundant about the spring at Kinney Ranch, but I am unable to say which of the species taken was the most common."—W. W. G.

40. **Vespertilio chrysonotus** *Allen*. GOLDEN-BACKED BAT.—One specimen, Kinney Ranch, July 21. (See *antea*, p. 240.)

41. **Scalops argentatus** *Aud. & Bach.* SILVERY MOLE.—One specimen, ♂ ad., Perch, Rock Co., Nebraska, Oct. 6.

42. **Blarina brevicauda** (*Say*). SHORT-TAILED SHREW.—Four specimens, 2 adult males and 2 adult females, Perch, Rock Co., Nebraska, Oct. 6–26.

"A rather rare species along the lake at Perch."—W. W. G.

43. **Sorex personatus** *Geoffroy St. Hilaire*. EARED SHREW.—Represented by an adult female, taken at Sherman, Wyoming, Sept. 9.

44. **Sorex personatus haydeni** (*Baird*). HAYDEN'S SHREW.—Represented by 4 specimens from Bassett (Oct. 4) and 10 from Perch (Oct. 9–15), Rock Co., Nebraska. About one-half are in winter coat, a few are still in summer coat, and the rest represent intermediate stages between the two pelages. The series measures as follows:

	Total Length.	Tail Vertebræ.	Hind Foot.
6 ♂ ♂	96 (86–100)	35.5 (30–38)	12 (11.5–13)
7 ♀ ♀	92 (88–98)	36.5 (29–38)	11.5 (11–12)

"Found in the same localities as *Blarina brevicauda*, but much more common."—W. W. G.

45. **Taxidea taxus** (*Schreber*). BADGER.—One skull, Otto, Wyoming, Aug. 1.

46. **Canis latrans** *Say*. PRAIRIE WOLF; COYOTE.—A litter of 4 young, Uncompahgre Indian Reservation, Utah, March 22. Also 1 skull, Otto, Wyoming.

47. **Canis nubilus** *Say*. GRAY WOLF; TIMBER WOLF.—Two skulls, Otto, Wyoming.

48. **Lynx rufus** *Raf.* BAY LYNX.—Two specimens, Otto, Wyoming, Aug. 1.

"Very abundant in the Big Horn Basin. Individuals were seen along the creek and on the sage-brush flats nearly every day."—W. W. G.

Article XVI.—PSITTACOTHERIUM, A MEMBER OF A NEW AND PRIMITIVE SUBORDER OF THE EDENTATA.

By Dr. J. L. Wortman.

The explorations of the Museum palæontological party in the Basin of the San Juan of New Mexico, during the past summer, secured, among other important materials, the larger part of an anterior limb of *Psittacotherium multifragum* Cope, associated with the lower jaws and a number of the upper teeth. The exact locality in which the specimen was found is near the head of the Cañon Escavada, in the upper horizon of the Puerco formation. The specimen in question was found by the writer, and, with the exception of a few unimportant weathered fragments, was bedded in its original matrix, a soft, friable, reddish-colored clay. The jaws and limb were not more than a foot or eighteen inches apart, so there can be very little doubt that they belong to one and the same individual. It may be further added that no other remains were found within several hundred feet of them.

Since the specimen in question presents characters of such unusual interest and importance, I have thought it advisable to give this brief preliminary account, which will be followed by a more exhaustive description, together with a critical review of the allied forms, copiously illustrated.

It has been the custom of palæontologists to place the genus *Psittacotherium*, after Cope, in the Tillodontia, but I will endeavor to show that it not only has no relationship with that group, but that with the genera *Hemiganus*, *Ectoganus* and *Stylinodon* it forms a closely connected and consecutive series ancestral to and leading directly to the Gravigrada or Ground Sloths. A second series, composed of *Onychodectes* and *Conoryctes* is clearly an allied group which probably led to the Armadillos.

These two series I herewith arrange under a new suborder, for which I propose the name Ganodonta, constituting a primitive division of the Edentata. It may be defined according to our present knowledge as follows: Primitive Edentates, characterized in the earlier forms by rooted teeth with divided fangs having a more or less complete enamel investment, in the later forms by the teeth becoming hypsodont, rootless, of persistent growth, and by limitation of the enamel to vertical bands in progressive decrease. They are further characterized by the presence of incisors in both jaws, by a typical molar and premolar dentition, by a trituberculate molar crown, which disappears early in life through wear, leaving the dentine exposed.

Of this suborder there are two families, viz.: Conoryctidæ, including *Conoryctes* and *Onychodectes*, and Stylinodontidæ, including *Hemiganus*, *Psittacotherium*, *Ectoganus* and *Stylinodon*. The lower Puerco representatives of these two families approach one another closely, the tooth structure of *Hemiganus*, *Onychodectes* and *Conoryctes* being very similar. *Hemiganus*, however, displays a type of lower jaw which, together with the foot structure, clearly foreshadows *Psittacotherium*, which in turn is undoubtedly the forerunner of *Ectoganus* and *Stylinodon*. This family would then be characterized by having a remarkably short, deep, and heavy lower jaw with an enormously developed coronoid process reaching even with, or in advance of, the posterior termination of the tooth-line. The fore foot is short, with remarkably abbreviated, deeply excavated first and second phalanges (unknown in *Hemiganus*), together with a powerful, highly compressed, deep claw; to this should be added a highly characteristic shortening of the facial portion of the skull. The Conoryctidæ, on the other hand, have more lengthened and slender lower jaws without special enlargement of the coronoid, elongated facial region of the skull, with much smaller and more rounded claws.

Family STYLINODONTIDÆ *Marsh.*

The genera of this family, with their definitions, are as follows:

Crowns of upper canines encased in enamel; canines not growing from persistent pulps; lower incisors faced with enamel; lower molars and premolars rooted with divided fangs and enamel-covered crown.......................*Hemiganus* Cope. Lower Puerco.

Crowns of upper canines with enamel confined to anterior face; canines not growing from persistent pulps; lower incisors faced with enamel; lower molars and premolars rooted with fangs connate, and enamel-covered crowns..*Psittacotherium* Cope. Upper Puerco.

Crowns of superior canines with enamel confined to anterior face; canines growing from persistent pulps; lower incisors without enamel; lower molars and premolars with connate fangs; enamel confined to vertical bands on inferior premolars................
Ectoganus Cope. Wahsatch.

Crowns of canines unknown, growing from persistent pulps; all lower teeth rootless, growing from persistent pulps; enamel of all lower molars and premolars confined to vertical narrow bands..........
Stylinodon Marsh. Bridger.

Of the limb of *Psittocotherium*, there are preserved the ulna and radius, the lunar, unciform, the greater part of the magnum, together with the third and fourth metapodials bearing their respective phalanges. The median and proximal phalanges of the second digit, with a part of the claw, are also preserved. On comparison of these bones with the corresponding parts of *Mylodon robustus*, the likeness is seen to be so striking that one would have scarcely any hesitancy in referring them to the same family. The metapodials are unusually short, which, with the two proximal phalanges, hardly exceed the claw in length. The proximal and median phalanges are short, robust, and deeply excavated at their articular extremities; the claws are enormously developed, somewhat compressed from side to side, with a marked curvature upon their dorsal surface. The third and fourth metapodials exhibit the same relations to each other and the carpal bones as do those of *Mylodon*, with a few unimportant exceptions. The ulna and radius are also strikingly megatheroid.

The evidence of the Edentate affinities of this suborder may be briefly summed up as follows: In the Stylinodontidæ the facial part of the skull is short, the incisors have undergone gradual diminution, the canines were enlarged as in *Megalonyx*, all the teeth finally came to be rootless and grew from persistent pulps, and what is yet most significant, the enamel came to be limited to narrow vertical bands with strong tendency to progressive disappearance, as is seen in the tusks of the earlier Proboscidea. The structure of the fore limb, so far as we know it, is almost identical with that of the large Ground Sloths; the distal end of the femur shows marked flattening, and the head of the humerus displays that peculiar pyriform pattern so highly characteristic of the South American Edentata.

In the Conoryctidæ there is the same evidence of the weak development of the enamel, accompanied by loss of incisors. The skeleton, so far as known, shows many striking similarities to that of the Armadillos, of which this family is in all probability ancestral. It would appear, therefore, and I think the proposition is now susceptible of demonstration, that the South American Edentata originated in this country, that they migrated from North America before the close of the Eocene period, and did not appear in South America until late in the Eocene or early in the Miocene time. Collateral evidence of this migration to the southward in the Eocene is seen in the disappearance of ***Meniscotherium*** of the New Mexico Wahsatch and the appearance of its allies, the Proterotheriidæ, later in South America.

Article XVII.—ON MAMMALS FROM THE SANTA CRUZ MOUNTAINS, CALIFORNIA.

By J. A. Allen.

The collections forming the basis of the present paper were made at Portola and La Honda, in San Mateo County, California, two small towns in the Santa Cruz or Coast Range of mountains. Portola is on the western slope, La Honda is on the eastern slope, the two localities being only about ten miles apart. The La Honda Collection was made during the week ending Jan. 2, 1895, by Messrs. W. W. Price and R. L. Wilbur, and numbers 236 specimens; the Portola Collection was made March 13 to April 16 (both inclusive), 1895, by Messrs. R. L. Wilbur and J. Diefenbach, for Mr. Price, and numbers about 400 specimens. I am indebted to Mr. Price for the opportunity of studying the entire series of about 650 specimens, of which about one-third was purchased by the Museum.

As the number of species contained in these collections is small, the common species are represented in large series, thus furnishing valuable information respecting the range of individual variation. The annotations given below relate mainly to this feature.

1. **Lepus trowbridgei** *Baird.*—Six specimens, collected at Portola, March 24–26.

2. **Perognathus californicus** *Merriam.*—Two specimens, Portola, March 25.

3. **Thomomys bottæ** (*E. & G.*).—Six specimens from Portola, collected March 23–April 3, present the following measurements :

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
4 ♂ ♂ . . .	244 (215–270)	66 (56–82)	30 (28–33)	7.4 (5–10.5)
2 ♀ ♀ . . .	208 (206–210)	51.5 (51–52)	25.5 (25–26)	8 (8– 8)

4. **Neotoma fuscipes** *Baird.*—This series includes about 50 specimens from La Honda, taken Dec. 25–Jan. 3, and about 100 from Portola, taken March 15–April 17. The La Honda specimens are all adult; the Portola series includes 4 immature examples, one of which is very young (less than one-fourth grown), and the other three are still in the plumbeous pelage, though nearly full grown.

This series of 150 specimens, from practically the same locality and taken at nearly the same season, is of interest as throwing light on the normal range of variation in respect to coloration, size, etc. The series from the two localities are practically indistinguishable as regards coloration; the slight apparent difference in measurements is doubtless due to the fact that the measurements of the two series were taken by different persons.

The larger or Portola series will be taken as the basis of the following comment.

Young.—The single very young specimen is similar in coloration to the nearly full-grown young, except that the dorsal surface is more profusely lined with black, giving a more blackish general effect. The full-grown young (total length, 335 to 359) vary from ashy plumbeous to dusky plumbeous, with a faint wash of pale buff on the sides and over the abdomen.

Adult.—Between the young examples just described and the next stage there is a wide gap as regards age, the rest of the series being all 'adult,' but the specimens may perhaps be roughly distinguished as 'young' adults, 'middle-aged' adults, and 'old' adults, on the basis of size and coloration. The smaller specimens, as a rule, are less rufous above, and less washed with fawn or reddish buff over the abdominal region. The younger specimens are generally yellowish brown above strongly lined with black, the middle of the dorsal area being often quite blackish, and the rest of the upper surface rather faintly yellowish brown. Below, the breast and anal region are white with a faint yellowish cast; abdominal area more or less washed with fawn color, the fur dusky at base. From this phase there is every gradation to the obviously 'old' adults, in which the whole upper surface is more or less strongly reddish brown, with much less black, and the lower surface, particularly the abdominal area, is rather strong fawn color, or even ochraceous buff. It is evident, however, that while this rather wide variation in color is largely due to age, there is also a wide range of individual variation, as some of the young adults are quite strongly reddish brown above, while some very old specimens almost altogether lack the reddish suffusion above and the fawn color below. Thus in some obviously old specimens the lower parts are white, or yellowish white, while in others the whole lower parts, including the breast, throat and anal region, as well as the abdomen, are deeply suffused with fawn, with in some cases the abdomen strongly ochraceous buff.

Feet.—The fore feet as a rule are white to the wrists, and the hind feet have the toes white to the base; but the white on the upper surface of the hind feet is frequently restricted to the apical half of the toes, but also frequently extends over the whole upper surface of the metatarsus, which is thus white or grayish white, with, of course, in different specimens, every intermediate stage.

There is no appreciable sexual difference in coloration, although the brightest colored specimens seem to be more frequently males than females. There is, however, a slight sexual difference in size, as shown by the following summary of measurements.

Measurements.—The series falls about equally on either side of a dividing line based on a total length of 420 mm. Of the La Honda series of 46 specimens—29 males and 17 females—25 exceed a total length of 420, and 21 fall below this measurement, divided sexually as follows: above 420, 20 males and 5 females; below 420, 9 males and 12 females.

Of the Portola series of 87 specimens—47 males and 40 females—39 exceed 420 and 48 fall below 420, divided sexually as follows: above 420, 27 males and 12 females; below 420, 20 males and 28 females.

La Honda Series.—The La Honda series presents the following averages and extremes:

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
29 ♂ ♂	...429 (388-480)	213 (192-230)	44 (41-46)	31.6 (30-35)
17 ♀ ♀	...408 (382-445)	198 (177-220)	42 (41-45)	31 (29-34)

Of the 29 males, 8 exceed a total length of 440; 3 reach or exceed 450; 9 fall to or below 420, and 7 to or below 410.

Of the 17 females, 1 only exceeds 440; 5 exceed 420; 12 fall below 420, and 7 below 400.

Portola Series.—The Portola series presents the following averages and extremes:

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
47 ♂♂	...423 (385–461)	217 (185–230)	41.5 (37–45)	31.5 (29–34)
40 ♀♀	...403 (380–456)	209 (182–230)	40 (36–46)	31 (29–34)

Of the 47 males, 8 exceed a total length of 440; 6 reach or exceed 450; 4 reach or exceed 460; 27 exceed 420; 20 fall below 420; 13 fall to or below 410; and 5 fall to or below 400.

Of the 40 females, 1 only exceeds 440; 12 reach or exceed 420; 28 fall below 420; 14 fall below 400.

Both Series.—Of the total of 133 adults—76 males and 57 females—48 males range between 400 and 440, and 28 fall outside these limits, of which 16 exceed 440 and 12 fall below 400; 34 females range between 400 and 440, and 21 fall outside these limits, of which only 2 exceed 440 and 21 fall below 400.

5. **Peromyscus californicus** (*Gambel*).—A series of 207 specimens, about one-third from La Honda and two-thirds from Portola, consist largely of adults, with, however, many nearly full-grown young of the preceding year. The variation in color among adults is not great, as regards the dorsal aspect of the animal; the ventral surface varies from clear ashy white with a trace of fulvous over the pectoral region (sometimes very pale but rarely wholly absent) to specimens in which the whole pectoral area is not only deep tawny ochraceous, but this color is prolonged medially to the abdomen, or even the whole ventral surface is strongly washed with ochraceous, most intense along the median line. About 20 per cent. of the specimens (40 out of 207) have the tip of the tail more or less white, the amount of white varying from a slight pencil of white at the tip to a white tip varying from half an inch to an inch in extent.

As regards measurements, specimens apparently fully adult present a considerable range of variation, as shown by 20 males and 10 females (the males outnumber the females as about 10 to 1) selected at random, as follows :

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
20 ♂ ♂	255 (244–270)	137 (125–156)	30 (28–31)	24 (22–26)
10 ♀ ♀	260 (245–285)	142 (126–155)	28.5 (27–30)	25 (23–27)

The females thus average slightly larger than the males.

6. **Peromyscus gilberti** *Allen.*—A series of 14 specimens (8 adults, 3 young adults, and 3 young in plumbeous coat) bear out the characters given in the original description (this Bulletin, V, 1893, p. 188). The adults all have a fulvous pectoral spot, varying in different specimens from a slight trace of fulvous to a very large and distinct spot of buffy ochraceous.

The adults measure as follows :

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
3 ♂ ♂	210 (201–220)	110 (105–117)	25 (25–26)	22 (22–23)
5 ♀ ♀	206 (200–215)	108 (101–114)	24 (23–25)	22 (21–23)

As before said, this species is in nearly all respects externally a miniature of *P. californicus.*

7. **Peromyscus texanus gambelii** (*Baird*).—This species is represented by 163 specimens, of which 44 were taken at La Honda, Dec. 23–31, and 119 at Portola, mostly during the last week in March. Throwing out all specimens obviously not adult, the collector's measurements of these two series present the averages and extremes given in the following table :

		Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
La Honda,	17 ♂ ♂	161 (150–177)	71.4 (61–85)	21.2 (20–23)	16.8 (16–18.5)
"	14 ♀ ♀	162 (147–181)	70 (63–80)	21 (19–23)	16.7 (16–18)
Portola,	26 ♂ ♂	165 (153–179)	75.5 (67–85)	20.6 (19–23)	17.1 (15.5–19)
"	22 ♀ ♀	163 (150–180)	75.4 (64–86)	20.3 (18–22)	16.7 (15–18)

The following will show the nature of the wide variation indicated in the above table :

Total length, 165 mm. or more....................18 ♂ ♂, 11 ♀ ♀
" " 175 " " ....5 ♂ ♂, 3 ♀ ♀
" " 160 " or less....................11 ♂ ♂, 15 ♀ ♀
" " 160 " to 170 mm....................21 ♂ ♂, 15 ♀ ♀

Thus 50 per cent. of the males and 42 per cent. of the females fall between 160 and 170 mm. (both numbers inclusive) in total length, and only $1\frac{1}{8}$ per cent. of the males, and rather less than 1 per cent. of the females, exceed a total length of 175.

As regards variations in color among adults, 'young adults' are darker and more heavily washed with blackish over the dorsal area than 'old adults,' about nine-tenths of which are very uniform in coloration, while about one in ten differs markedly from the average style. The variation is mainly in two directions—(1) toward excessive pallor or grayness; (2) toward a rufescent shade, in which the dorsal area is more or less strongly suffused with cinnamon rufous, varying much in intensity in different individuals. The rufescent phase is about twice as frequent in the present series as the pallid phase. Extreme examples, considered by themselves, might prove quite misleading.

8. **Reithrodontomys longicauda** (*Baird*).—A series of 16 males and 24 females, collected at La Honda, Dec. 23–31, give the following measurements:

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
16 ♂ ♂	...137 (125–150)	70 (64–76)	17.5 (17 –18)	13.5 (12.5–15)
24 ♀ ♀	...138 (124–154)	70 (63–80)	17.4 (16.5–18.5)	13 (12.5–14.5)

About 5 per cent. of the series range in total length from 124–130 mm.; these are probably young of the preceding year; but they differ in coloration from adults only in being more varied with blackish on the dorsal area. Throwing out these 'young adults' would raise the average total length to about 140 mm.

9. **Microtus edax** (*Baird*).—A series of 8 adults (2 ♂ ♂, 6 ♀ ♀) from La Honda, Dec. 25–Jan. 2, measure as follows: Total length, 170 (161–172, one specimen 198); tail vertebræ, 47 (42–50, one specimen 58); hind foot, 21.5 (19–23); ear, 14.7 (13–17).

10. **Tamias pricei** *Allen.*[1]—A series of 45 specimens, apparently all practically adult, taken at Portola by Wilbur and Diefenbach, March 23–April 15, and consisting of about an equal number

[1] *Tamias pricei* Allen, Bull. Am. Mus. Nat. Hist., VII, 1895, p. 333.

of males and females, is remarkably uniform in coloration, there being no variation in this respect calling for remark. In measurements, throwing out a few specimens with obviously mutilated tails, the variation is shown by the following:

	Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
23 ♂ ♂	...252 (234–278)	119 (109–130)	37 (34–39)	21.5 (19–23)
17 ♀ ♀	...256 (241–271)	122.5 (113–130)	35 (32–37)	22 (20.5–24)

The females thus average slightly the larger, except in respect to the hind foot, which, according to the collector's measurements, is slightly longer in the male.

11. **Mus musculus** *Linn.*—A series of 8 specimens is included in the La Honda series.

12. **Sciurus fossor** *Peale.*—One specimen, La Honda, Dec. 24.

13. **Sorex montereyensis** *Merriam.*—A series of 18 specimens (5 ♂ ♂, 13 ♀ ♀), collected at La Honda, and 15 specimens (6 ♂♂, 9 ♀♀) taken at Portola; measure as follows:

		Total Length.	Tail Vertebræ.	Hind Foot.	Ear.
Portola........	6 ♂ ♂,	109 (102–117)	46.3 (44–48)	13 (12–14)	8.3 (8–9)
"	9 ♀ ♀,	112 (105–120)	49 (45–53)	13.4 (12–14)	7.3 (7–9)
La Honda.....	5 ♂ ♂,	122 (118–127)	48 (46–51)	15 (14–15.5)	7.5 (7–8)
"	13 ♀ ♀,	116 (111–125)	48 (44–52)	14.5 (14–15)	7.8 (7–8)

For some not very evident reason the Portola specimens fall considerably below the La Honda series. There is no appreciable difference in other characters.

Of the 34 Shrews taken at these localities, all but one appear to be *S. montereyensis*; the other is referable to *S. californicus*.

14. **Sorex californicus** *Merriam.*—La Honda, ♂ ad., Dec. 28, Price and Wilbur. Total length, 95; tail vertebræ, 33; hind foot, 12; ear, 6.

15. **Neürotrichus gibbsii** (*Baird*).—An adult female, collected at Portola, April 6, by J. Diefenbach, carries the range of

the species considerably farther south than is indicated by previously published records. The specimen measures: Total length, 117; tail vertebræ, 38; hind foot, 14.

16. **Scapanus townsendii** (*Bachman*).—A single specimen is contained in the collection from Portola.

Article XVIII. — NOTES ON BIRDS OBSERVED IN YUCATAN.

By Frank M. Chapman.

Our knowledge of the bird-life of the peninsula of Yucatan is more complete than the literature relating specially to the subject would lead one to suppose. A bibliography of the papers on Yucatan ornithology contains few titles, but a catalogue of the existing collections of Yucatan birds would enumerate many thousand specimens.

By far the largest number of these have been collected by Dr. George F. Gaumer, formerly of Kansas, and now a practicing physician in Izamal, Yucatan, who, for the past eighteen years, has been a persistent and successful collector of the Yucatan flora and fauna.

During the early part of this period Dr. Gaumer's birds were secured by the commercial naturalist, Adolphe Boucard, of Paris; later his collections were disposed of to Messrs. Salvin and Godman. These naturalists also obtained the major portion of the specimens collected for Boucard. With the exception of a paper in the 'Proceedings' of the Zoölogical Society, and one or two minor publications, Dr. Gaumer's collections from the peninsula have never been separately reported upon. They have, however, been incorporated in the 'Biologia Centrali-Americana,' to which work the student of Yucatan birds must refer.

The fact that Dr. Gaumer travelled extensively over the peninsula, in connection with the uniform character of the ground, renders it extremely probable that the list of Yucatan birds, at least of the permanent and summer resident species, is complete. Future work in this region, therefore, should increase our knowledge of the habits, local distribution, and especially the migrations of Yucatan birds. As a contribution to this end I present the following observations, including a 'local list'—the first list, I believe, to be published from one locality, the value of which lies chiefly in the fact of its showing the winter avifauna of a restricted territory.

The peninsula of Yucatan is a geologically recent addition to the mainland, of Pliocene and Postpliocene age. In some places the formation is entirely a shell conglomerate; in others it has become a hardened limestone.

With the exception of a range of hills in its central part, the peninsula is flat. The surface is composed largely of exposed rock, which is exceedingly uneven, being pitted, seamed and carved into innumerable small pot-holes, hollows, caves and minor irregularities. In the depressions and pockets there is a scanty deposit of earth.

The northern half of Yucatan has long been deforested, and the growth is now a dense scrub of trees and saplings, averaging one and a half to three and a half inches in diameter and fifteen to thirty feet in height. The earth will not support a crop for many successive plantings, and as a result old areas are abandoned and new ones cleared so frequently that throughout the region visited by me this scrubby wood is so alike in appearance as to deceive one into believing that it constitutes the true sylva of the country. But Dr. Gaumer, to whom I am indebted for much valuable information, tells me that this condition is artificial, and that in the less populated, southern half of the peninsula, tropical forests, composed of heavy first-growth timber, exist. He also pointed out to me the remains of this forest in northern Yucatan in the shape of certain trees (sapote or sapodillo), which, because of the value of their sap, had been spared.

With one or two minor exceptions there are no surface streams in Yucatan. Water is therefore obtained from artificial or, for the most part, natural wells termed 'cenotes.' These correspond to the 'sinks' of middle Florida, but are generally larger and deeper. They seem to be supplied by subterranean streams. These cenotes are sometimes 80–100 feet in depth and 200 feet in diameter. They are circular in outline, the walls being occasionally perfectly perpendicular from top to bottom, or, when the earth has crumbled in about the edges, a sloping side is formed. The banks of cenotes of this character, through the presence of earth and moisture, support a fairly luxuriant vegetation, in strong contrast with that of the surrounding country. Naturally, large numbers of birds are attracted to these oases.

The dry and wet seasons in Yucatan are well defined, the former beginning about November and continuing until May or June. During this period rain is infrequent, and there is little or no dew. Most of the trees lose their leaves, and the woods as a whole assume a grayish brown tint with just enough of green to suggest the appearance of a fifteen-year-old second growth in the vicinity of New York City, about May 10. The fields are brown and parched, and the region seems comparatively arid and sterile. There is thus a much greater difference between the winter and summer vegetation than in those parts of the tropics where the deep rich soil holds moisture, and supports a vegetation which in turn condenses dew.

The animal life of the country is of course much affected by these conditions, and in no tropical country that I have visited has winter been so strongly suggested. This is particularly marked with the birds, and the most interesting fact developed in the study of Yucatan bird-life is the regular, bi-annual migrations of many breeding species.

Dr. Gaumer writes (P. Z. S., 1883, 436): "The birds disappeared as the dry season advanced, except a few of the common resident species, which lived about the ranchos and at the aguados, where water was to be found. On the 23d of May the first of the summer showers occurred, which was soon followed by daily showers at midday. All nature changed as if by magic ; new leaves grew, and the forests were again populated with sweet songsters."

Data are lacking to show how regular this movement is, and whether it is closely dependent upon the periods of rain ; but the fact remains that we have in Yucatan a large number of birds who migrate to and from their breeding grounds, and that in a tropical avifauna a class of summer residents has been formed through climatic influences.

Yucatan bird-life, as might be expected, has been derived from Mexico and Central America. With two exceptions, *Zenaida zenaida* and *Petrochelidon fulva*, the avifauna is without a West Indian element. The first of these birds occurs only on the coast, the second is a locally common resident. Both are birds of strong flight, and their presence in Yucatan cannot be considered as evidence in support of the theory of a former land connection with Cuba.

The peninsularity of Yucatan, in connection with environmental conditions, has evidently resulted in the formation of some fifteen or twenty races, slightly differentiated from their Mexican or Central American derivatives. It has also apparently assisted in preserving some species whose range in Mexico or Central America is now restricted to the region bordering Yucatan. The most striking case of this kind is furnished by the Ocellated Turkey (*Agriocharis*[1] *ocellata*), which is found throughout Yucatan, and is elsewhere known only in British Honduras and Guatemala. By far the larger part of its range, therefore, is included in Yucatan. But both the geologic and natural history of Yucatan clearly show that this remarkably distinct bird could not have been evolved there, nor can we suppose that the comparatively small area it inhabits in British Honduras and Guatemala can have constituted its range prior to the formation of Yucatan. It therefore seems a fair assumption that while its continental range has been restricted, the conditions of peninsular existence have proved favorable to its increase.

This, with several similar cases, may aid us in explaining the presence in Yucatan of a number of birds which, as far as known, have no representatives in any other region. *Piranga roseigularis*, *Icterus auratus*, *Antrostomus yucatanicus*, *Melanerpes rubriventris*, with two or three others, compose this class. As with *Agriocharis ocellata*, these birds appear too distinct to have originated in Yucatan, and it seems probable that either they have become extinct in the adjoining regions, or have not as yet been discovered there.

Comparing the avifauna of Florida with that of Yucatan we find they possess several points in common. The peninsula of lower Florida is but slightly older, geologically, than Yucatan, and its bird-life has also been largely derived by immigration from the mainland to which it is attached. As in Yucatan, differentiation has resulted from peninsulation, and we have numerous races whose relationships are evident. There are also two birds, the Paroquet (*Conurus carolinensis*) and Ivory-billed Woodpecker (*Campephilus principalis*), whose ranges have become much re-

[1] New genus; see p. 288.

stricted during recent years and, with the exception of a few localities in the lower Mississippi valley, these birds are now confined to Florida. The time is not far distant when the Paroquet, at least, will exist only in southern Florida; then we shall have a case in distribution not unlike those found in Yucatan.

The relationship of the avifauna of Cozumel Island to that of Yucatan is exceedingly interesting. This island is about ten miles off the east coast of Yucatan, and is some twenty-five miles long and ten miles in width. Mr. Salvin remarks (Ibis, 1885, p. 185): "The geological formation appears to be similar to that of the adjoining coast, and consists of a porous limestone, through which all rain at once passes, so that there are no surface-streams or rivers anywhere in the district."

The exploration of Cozumel, some eleven years ago, by the naturalists of the Fish Commission, Mr. Devis, and Dr. Gaumer, resulted in the remarkable discovery of between fifteen and twenty forms peculiar to the island. As might be supposed, the larger number of these have been derived from the contiguous mainland, but one species has no close relative nearer than Panama; another is not represented, even generically, nearer than Vera Cruz, while several are representatives of genera peculiar to the West Indies.

It seems probable, therefore, that Cozumel has always been an island, and that, unlike the peninsula of Yucatan, it has received its avifauna not through direct contact with the mainland, but, because of its insulation, has been populated more or less fortuitously. Yucatan being the nearest land, has, as might be expected, contributed the largest share of Cozumel bird-life, but the fact that so great a number of birds may be restricted to a small island within sight of the mainland, shows how sedentary are many species of tropical birds. It does not follow, therefore, that proximity to Yucatan implies a fauna entirely derived from Yucatan. Islands are not populated by immigration, but by the more or less accidental occurrence in them of waifs and strays, generally from the surrounding regions, but sometimes from distant regions. In this way I would account for the Vera Cruz, West Indian, and Panama elements in the Cozumel fauna.

A List of Birds Observed at Chichen-Itza, Yucatan, from March 3 to 21, 1896.

Chichen-Itza is situated in north-central Yucatan. To reach it one takes the train from Progreso to Izamal *via* Merida. At Izamal a *volan coché* is procured for the journey of thirty-five miles to Ditas, from which place horses and mules convey one to Chichen, distant twelve miles.

Chichen-Itza, famous for its impressive Maya edifices, is now the property of Mr. Edward H. Thompson, formerly American Consul at Merida, and well known for his archæological explorations in Yucatan. It was through Mr. Thompson's courtesy and the hospitality of his *mayordomo*, Don Santiago Bolio, that I was privileged to visit Chichen, and I desire to express here my thorough appreciation of the favors I received at the hands of these gentlemen.

In Izamal it was my fortune to be the guest of Dr. and Mrs. Gaumer, and I would thank the latter for her cordial hospitality as warmly as I do the former for his kindness in supplying me with much valuable information and practical assistance.

As a matter of convenience, the classification of the 'Biologia Centrali-Americana' has been followed.

1. **Polioptila cærulea** (*Linn.*). Blue-gray Gnatcatcher.—One to three were seen almost daily. No songs were heard.

2. **Thryothorus albinucha** (*Cabot*). Cabot's Wren.—A very common bird, resembling in its notes and actions *Thryothorus ludovicianus*.

3. **Thryothorus maculipectus canobrunneus** *Ridgw.* Temax Wren.—Not quite so common as *T. albinucha*. The two birds resemble each other in their actions and choice of haunts, but differ markedly in notes, and evidently represent two different branches of their genus. The notes of *T. albinucha*, as before stated, agree with those of the more northern

T. ludovicianus, while the notes of *T. m. canobrunneus* are very much like those of the more southern *T. hyperythrus*.

4. **Hemiura brevicauda** (*Lawr.*). YUCATAN HOUSE WREN.—Common and occasionally heard singing, the song closely resembling that of *Troglodytes aëdon*. Two birds of this species were found occupying a nest which, with little doubt, was that of *Rhynchocyclus cinereiceps*. The latter bird was not observed, and is evidently only a summer resident at Chichen. The known nests, however, of birds of this genus, are too characteristic to be mistaken. The nest of this species, discovered by Mr. C. C. Nutting, has been described by Mr. Ridgway,[1] and I have found several similar nests of *R. sulphurescens* in Trinidad.[2] The Wrens had relined their home with fine dry grasses, and after seeing them use it daily for over a week, I naturally supposed that they were nesting. But the ease with which one may reach a false conclusion was well illustrated when on the capture and dissection of these two Wrens they both proved to be females!

5. **Mniotilta varia** (*Linn.*). BLACK-AND-WHITE WARBLER.—Three were seen.

6. **Dendroica virens** (*Gmel.*). BLACK-THROATED GREEN WARBLER.—A female, taken March 12, was acquiring two lesser coverts in the left wing, but shows no other signs of molt in progress.

7. **Seiurus aurocapillus** (*Linn.*). OVEN-BIRD.—Seen on eight occasions.

8. **Geothlypis trichas** (*Linn.*). MARYLAND YELLOW-THROAT.—Two or three were seen daily. No notes were heard beyond the characteristic *chit*.

9. **Icteria virens** (*Linn.*). YELLOW-BREASTED CHAT.—Three Chats were seen, one of which was positively identified as *virens*.

[1] Proc. U. S. Nat. Mus., V, 1882, p. 395.
[2] Bull. Am. Mus. Nat. Hist., VI, 1894, p. 39.

10. **Granatellus sallæi boucardi** *Ridgw.* Boucard's Warbler.—A female (?) taken March 2, was the only bird of this species observed.

11. **Sylvania mitrata** (*Gmel.*). Hooded Warbler.—Nine individuals were seen. A female, taken March 17, has no black on the throat or breast and only a faint indication of this color along the upper border of the yellow parts of the forehead and cheeks. A second female, taken March 18, has a throat patch of the usual size, composed of feathers which are mottled yellow and black. The feathers of the crown and those bordering the auriculars are black tipped with olive green. Neither specimen shows signs of a molt in progress.

12. **Setophaga ruticilla** (*Linn.*). Redstart.—Seven individuals were observed.

13. **Vireo flavifrons** *Vieill.* Yellow-throated Vireo.—Two singing birds were noted.

14. **Vireo noveboracensis** (*Gm.*). White-eyed Vireo.—One or two were seen daily. Occasionally they were heard calling, and on March 2 a song was heard.

15. **Vireo ochraceus** *Salv.* Ochraceus Vireo.—Very common. Like the White-eyed Vireo, this bird frequents undergrowth. In notes, however, there is no resemblance between the two species.

16. **Cyclorhis flaviventris yucatanensis** *Ridw.* Yucatan Cyclorhis.—Tolerably common. Its call resembles that of the Trinidad *C. flavipectus*, but seemed to me to possess one more note.

17. **Stelgidopteryx serripennis** (*Aud.*). Rough-winged Swallow.—Abundant. It roosted in holes and crevices of the ruins, appearing early in the morning, and again just before sunset.

18. Euphonia hirundinacea *Bonap.* BONAPARTE'S EUPHONIA.—A male of this species, taken March 18, was singing an exceedingly sweet and varied song, which was possessed of sufficient volume to be heard at a considerable distance. It was continuous, and included imitations of the notes of several birds, among others those of the White-eyed Vireo.

19. Piranga roseigularis *Cabot.* ROSE-THROATED TANAGER.—Not uncommon a mile or more from the hacienda, in the larger wooded growths, where it frequented the tops of the trees. All the males observed—and I have heard eight in a morning—were in song, but dissection showed little or no evidence of the approach of the breeding season. The song of this species is attractive and musical. It bears some resemblance to that of the Rose-breasted Grosbeak, but is shorter and not so loud. The song of an immature male was noticeably different from that of the adult. This bird, taken March 4, is indistinguishable from an adult female in color, evidently proving that at least two years are required for the acquisition of the full plumage.

20. Phœnicothraupis rubicoides (*Lafr.*). ROSE TANAGER.—Not common. Found in the woods, generally near the ground. It is a rather shy, excitable bird, and, on being alarmed, utters a harsh, scolding, Wren-like note.

21. Saltator atriceps (*Less.*). BLACK-HEADED TANAGER.—Common about the borders of clearings, and sometimes seen feeding on the ground in neighboring pasture-lots. It is an active, rather suspicious bird, with a painfully sharp, steely alarm-note.

22. Cardinalis cardinalis yucatanicus *Ridw.* YUCATAN CARDINAL.—Common. In notes and habits this subspecies resembles *C. cardinalis*, but its brighter coloration is evident even at a distance.

23. Passerina ciris (*Linn.*). PAINTED BUNTING.—Seven individuals were observed. A male, taken March 5, is in the plumage of the female, but has several blue feathers on either side of the head.

24. **Arremonops rufivirgata striaticeps** *Ridgw.* STRIPED-CROWNED SPARROW.—Abundant. Sometimes as many as fifty were seen in a morning. They are quite generally distributed in the undergrowth about the borders of clearings, where they pass much of their time on the ground. March 13 they began to sing, and within a few days they were singing in numbers. The song suggests that of the Field Sparrow, but is a much humbler effort.

25. **Amblycercus holosericeus** (*Licht.*). WEDGE-BILLED BLACKBIRD.—Tolerably common in and about the borders of the cornfields, where its loud, mellow whistle was occasionally heard. It is a bird of singular habits, suggesting both an Oriole and a Woodpecker. It hunts along limbs as patiently as a Creeper, tapping here and there or pounding vigorously in its efforts to secure food from cracks and crevices. In short flights it presents a laughable appearance. It progresses by jerky wing-beats, and at the end of each stroke the tail is thrown forward over the head.

26. **Callothrus robustus** (*Cab.*). RED-EYED COWBIRD.—Common about the corral and in the cornfields. A flock of about twenty birds visited the hacienda corral daily. At midday they retired to roost in a row on a stone fence beneath the shade of a thatched roof, but at other times they were walking actively about feeding. Occasionally one would rush up to another with a series of bouncing hops, but just as a collision seemed inevitable, the bird would stop and point its bill to the zenith in a most ludicrous manner. Occasionally, without apparent cause, they would all take wing, arising as one bird, and then, after a short flight over the corral, return to the ground where, after a moment's perfect stillness, they resumed feeding. The bright red eye of the adult birds gives them a peculiar, glaring expression. Immature birds have the iris brownish yellow.

27. **Icterus giraudi** *Cass.* GIRAUD'S ORIOLE.—Orioles of three species were numerous in certain blossoming trees, and were also found feeding among the weedy growth in old clear-

ings. They were shy, active and musical, whistling their call-notes and parts of songs as they passed from place to place. The present species and *I. auratus* seemed to be equally common, while *I. gularis* was more numerous.

28. **Icterus auratus** *Bonap.* GOLDEN ORIOLE.—Apparently about as common as the preceding species, though their resemblance in color to one unfamiliar with them renders field identification rather uncertain. I secured two specimens of each species.

29. **Icterus gularis** (*Wagl.*). BLACK-BACKED ORIOLE.—More common than either of the preceding species, with which it was often found associated.

30. **Dives dives** (*Licht.*). PUEBLO BLACKBIRD.—This I found to be the most characteristic bird of Yucatan towns, where it is far more abundant than in the country. Their loud, rather musical, whistling calls, are among the first sounds to be heard in the early morning, as the birds, perched in the topmost branches of the higher trees, respond to one another's challenge or salute.

31. **Xanthoura guatemalensis** *Bon.* GUATEMALA GREEN JAY.

Xanthoura cyanocapilla AUCT. *nec* CAB.
Xanthoura luxuosa SALV. & GODM. Biol. Cent. Am. Aves, I, 502 (in part).
Xanthoura guatemalensis BON. Consp. Av. I, 1850, 380.

Not uncommon about the borders of clearings and in the cornfields. Its notes recall the *jay, jay* of *Cyanocitta cristata*, but are not so loud and are less often uttered.

In a series containing forty specimens of this species and the Mexican *luxuosa* I find no indication of intergradation. Eight specimens of *luxuosa* from Tehuantepec closely agree with twenty from the lower Rio Grande, and differ markedly from the yellow-bellied *guatemalensis*, of which I have seven specimens from Yucatan and two from Guatemala.

Cabanis's name *cyanocapilla* (Fauna Peruana, II, 233) has generally been applied to the Central American and Yucatan birds. Cabanis evidently described a specimen from Jalapa, which, both from his description ("Die Unterseite ist stark hellgrün angeflogen") and the locality (there is a specimen of *luxuosa* from Jalapa in the Museum), was evidently *luxuosa*, of which the name *cyanocapilla* is apparently a pure synonym.

32. **Psilorhinus mexicanus** (*Wagl.*). Brown Jay.—Rather uncommon. It was found in pairs and trios in the woods, and was rather shy and suspicious. Its call-note resembles the Blue Jay's (*Cyanocitta cristata*) imitation of a Red-shouldered Hawk's scream, but is louder and harsher.

33. **Cissolopha yucatanica** (*Du Bois*). Yucatan Blue Jay.—This was the most abundant bird observed. It was generally found in small flocks of six to twelve individuals, which seemed to have their headquarters in certain parts of the woods where they could always be found. They were especially numerous in old cornfields, forty or fifty being seen daily scattered about one cornfield near the hacienda. An intruder on their preserves is at once greeted by a chorus of harsh cries and a variety of quite indescribable calls. The birds in the immediate vicinity of the hacienda were comparatively wary, but those seen in the depths of the woods were surprisingly tame. Their curiosity was evidently much aroused by my appearance, and perching within six or eight yards, they would lean down and inspect me in an almost human way, all the time uttering their peculiar notes.

Current descriptions of this bird, including that in the 'Biologia,' ascribe the differences shown by certain individuals in the color of the bill and tail to sex, the male being stated to have a black bill and tail, while the female is said to have the bill yellow and the tail tipped with white. My series of twelve specimens shows that this variation is not sexual, but is evidently due to age. Thus I have males and females with black bills and tails, and also examples of both sexes in which the bill is yellow and the tail tipped with white. The series also contains intermediates between the two extremes.

How long a time is required for the acquisition of the adult plumage remains to be determined. Apparently at least two years, for each group of Jays had several yellow-billed individuals, about one in every four birds giving evidence of immaturity.

34. **Myiozetetes texensis** (*Giraud*). GIRAUD'S FLYCATCHER.—Observed on seven occasions.

35. **Megarhynchus pitangua** (*Linn.*). LARGE-BILLED TYRANT.—Not uncommon.

36. **Empidonax minimus** *Baird.* LEAST FLYCATCHER.—Not uncommon. No call-note was heard.

37. **Contopus brachytarsus** (*Scl.*). SHORT-LEGGED PEWEE.—Tolerably common. Its note is a low, rolling or trilled twitter, entirely unlike that of *Contopus virens*, which this species so much resembles in color.

38. **Myiarchus cinerascens** (*Lawr.*). ASH-THROATED FLYCATCHER.—Two of the three birds seen were secured. The call of a male resembled in form that of *M. crinitus*, but differed sufficiently to be at once distinguished as belonging to another species.

39. **Myiarchus yucatanensis** *Lawr.* YUCATAN FLYCATCHER.—Common. Its call-note is a complaining, whistled *whirt*, which is sometimes followed by a rather rapid musical roll. Three males, taken March 18 and 20, had the testes much enlarged, and the breeding season was evidently near at hand.

Comparison of my six specimens with Mr. Lawrence's type of *yucatanensis* from Merida, prove them to be typical of that species. Further comparison with twenty April to June specimens of *M. lawrencei* from Tamaulipas and Nuevo Leon in Mr. Sennett's collection, show well-marked differences between these two birds. As before pointed out by several writers, *lawrencei* has a slightly broader and decidedly more depressed, flatter bill, but there is also a readily apparent difference in color. This is best shown in the crown, which approaches clove brown (*cf.* Ridgway's Nomenclature of Colors) in *lawrencei* but is redder and nearer prouts brown in *yucatanensis*. In the latter, also, the back is less greenish and the belly averages paler, but this is apparent only upon comparing a series. In size, *yucatanensis* averages slightly the smaller.

40. **Tyrannus melancholicus** *Vieill.* MEXICAN KING-BIRD.—A male, taken March 20, was the only one observed.

41. **Tityra personata** *Jardine & Selby.* MEXICAN TITYRA.—Three of four specimens, observed on March 20 and 21, were secured. The testes of two males were much enlarged, while the ovaries of a female were slightly developed.

42. **Dendrocincla anabatina** *Scl.* WOOD-HEWER.—A male was taken March 17.

43. **Dendrocincla homochroa** (*Scl.*). WOOD-HEWER.—A male was taken March 14.

44. **Dendrornis flavigastra** *Sw.* WOOD-HEWER.—Tolerably common.

45. **Thamnophilus doliatus mexicanus** *Allen.* MEXICAN ANT-THRUSH.—Not common. Its song, while differing from that of *T. doliatus* in Trinidad, is nevertheless sufficiently like it to show the relationship between the two birds.

46. **Chlorostilbon caniveti** (*Less.*). CANIVET'S HUMMING-BIRD.—Not uncommon. A female taken March 4 had much enlarged ovaries.

47. **Lampornis prevosti** (*Less.*). PREVOST'S HUMMING-BIRD.—A female taken March 12 had slightly enlarged ovaries.

48. **Amazilia cinnamomea** (*Less.*). CINNAMON HUMMINGBIRD.—A male, taken March 13, had much enlarged testes.

49. **Amazilia yucatanensis** (*Cabot*). CABOT'S HUMMING-BIRD.—A female taken March 18 had much enlarged ovaries.

The condition of the sexual organs in the four species just mentioned renders it evident that with Hummingbirds the breeding season was at hand.

50. **Nyctidromus albicollis merrilli** *Senn.* MERRILL'S PARAUQUE.—Common, its call of *ker-whe-you*, being heard each night and early morning. I was surprised to learn how rapidly these birds can run. On one occasion two lit within a few feet of me when it was light enough to distinguish their movements. They crouched close to the earth, sometimes running quickly and with unexpected ease for a few steps, then turned their heads sharply from side to side as though looking for insects. They would also spring suddenly fifteen feet into the air to catch a passing insect.

Three males from Yucatan, including one taken in June, on comparison with a series of twenty specimens of *merrilli* from Texas, are obviously to be referred to this form.

51. **Melanerpes rubriventris** (*Sw.*). SWAINSON'S WOODPECKER.—Tolerably common.

52. **Melanerpes dubius** (*Cabot*). UXMAL WOODPECKER.—Common.

53. **Dryobates scalaris parvus** *Ridgw.* CABOT'S WOODPECKER.—The few individuals observed of this species were exceedingly shy. Their call-note is a sharp *peek* resembling that of *Dryobates pubescens*.

54. **Ceophlœus scapularis** (*Vig.*). DELATTRE'S WOODPECKER.—Not uncommon.

55. **Eumomota superciliaris** (*Sw.*). RED-BACKED MOTMOT.—About ten individuals were observed. Its note is well described by Dr. Gaumer as *tah*.

56. **Crotophaga sulcirostris** (*Sw.*). GROOVE-BILLED ANI.—Common about the pastures, where it was often seen picking ticks from the cattle. It seems less sociable than *C. ani*, and single birds were often observed; whereas, in my experience, it is unusual to find an individual of *C. ani* alone. Its note is a prolonged *chee-wyyah*, easily distinguishable from the single whining whistle of *C. ani*.

57. **Amazona albifrons** (*Sparrm.*). WHITE-FRONTED PARROT.—Not uncommon, from two to five birds generally being associated.

58. **Conurus aztec** *Souancé.* AZTEC PAROQUET.—Common in small flocks of from two or three to twenty individuals.

59. **Glaucidium phalænoides** (*Daud.*). FERRUGINOUS PIGMY OWL.—Common; resembling in notes and habits individuals of the same species observed in Trinidad.

60. **Falco rufigularis** (*Daud.*). RED-THROATED FALCON.—A pair of these birds made their headquarters at one of the cenotes. Both were adult, but one was observed bringing food to the other. Their call-note was a high, rapidly-repeated squeal, somewhat suggesting the Sparrow-Hawk's call.

61. **Falco sparverius** (*Linn.*). SPARROW-HAWK.—Six or eight individuals were observed, two of which were secured.

62. **Rupornis ruficauda** (*Scl. & Salv.*). RUFOUS-WINGED HAWK.—Not uncommon. Its note is a single sharp squeal, repeated at short intervals.

63. **Herpetotheres cachinnans** *Vieill.* CRYING HAWK.—Common. The notes of this Hawk are more human and weird in character than those of any bird I have ever heard. The first individual I observed was perched on a tree growing from the top of a Maya temple. From this lookout it mocked me with a truly maniacal laugh until I had almost reached shooting distance, when, with a loud chuckle, it flew away. I did not hear this call again, but an even more uncanny one was heard each night and morning from several birds of this species living near the ruins. This is described in my journal as resembling a call of a man in great pain, and ending in an agonized wail. It was gruesome beyond description, and finally became so unpleasant that I would gladly have turned every *Herpetotheres* within sound of the hacienda into a museum specimen.

The native name of this bird is 'Koss.' Its notes should cause it to figure prominently in Indian folk-tales.

64. **Cathartes aura** (*Linn.*). TURKEY VULTURE.—Three or four were seen daily.

65. **Catharista atrata** (*Bart.*). BLACK VULTURE.—Somewhat less numerous than the Turkey Vulture.

66. **Columbigallina passerina pallescens** (*Baird*). MEXICAN GROUND DOVE.—Common.

67. **Columbigallina rufipennis** (*Bonap.*). RUFOUS GROUND DOVE.—Common, fifty or more sometimes being seen feeding together in the cornfields. March 25 a pair of these birds was nesting in an orange-tree in Dr. Gaumer's garden.

68. **Melopelia leucoptera** (*Linn.*). WHITE-WINGED DOVE.—Abundant. In early morning and late afternoon these birds could be found in large numbers in the old cornfields. They were also seen feeding on the seeds of certain pod-bearing trees. During the middle of the day they frequented the banks of the cenotes, which they doubtless visited for shade as well as water.

Their flight is accompanied by a loud whistling sound, louder than that produced by *Zenaidura macroura* when flying. Their call is a loud, long crowing, which may be written: *Cookeree-cookeree-coo-ree-coo, crow-co-er-coo, crow-co-er-coo.* It suggests the first efforts of a young cock.

69. **Leptotila fulviventris brachyptera** (*Salvad.*). WHITE-FRONTED DOVE.—Abundant. This bird's call is a short, soft *coo*. Its flight is usually noiseless, but is sometimes accompanied by a whistling sound.

70. **Columba flavirostris** *Wagl.* RED-BILLED PIGEON.—Not common. Its call is a fine, loud *cöo—whoo-er-whoo.*

71. **Agriocharis ocellata** (*Temm.*). OCELLATED TURKEY.—This magnificent bird was apparently common. It was not as yet calling, and the only means I had of determining its numbers was by actual observation. The flesh of the birds is, however,

so highly prized by the Indians, who doubtless have always hunted it, that it has become one of the wariest birds I have ever collected. At the best, therefore, its capture is a difficult matter, and my ignorance of both the bird and its haunts were serious handicaps. It was not until a week after my arrival that I succeeded in shooting one of these Turkeys. During this period I made their capture my chief object, doing no general collecting near the old cornfields until I had ascertained whether Turkeys were present. As a result I saw from one to six daily.

The only note I heard was a low *pŭt*, but Dr. Gaumer writes (P. Z. S., 1883, p. 461) that "during the breeding season, which is in May and June, the male makes a peculiar drumming noise, very deep and sonorous; after this he utters his peculiar song, which resembles the rapid pecking of a distant Woodpecker or the song of the great Bull Toad."

The marked differences in color and form which exist between the Ocellated Turkey and the members of *Meleagris gallopavo* group, seem to me of more than specific value.

The differences in the form and distribution of the warty excrescences of the head and neck, and in the character of the erectile appendages of the forehead,[1] the more highly graduate tail and more rounded rectrices, the absence of a beard in the male and presence of rudimentary spurs in the female are all characters which entitle *ocellata* to generic distinction, and I would suggest, therefore, that it be placed in a new genus, for which I propose the name *Agriocharis*.[2]

72. **Ortalis vetula pallidiventris** *Ridgw.* YUCATAN CHACHALACCA.—Common. Each morning at about 7 o'clock these birds were heard calling. They evidently call in pairs, one bird beginning and the other soon joining. Their voice is very loud and strongly suggests the *clanging* of a Wild Goose's *honk*, a trumpet-like tone it may derive from the elongation of the trachea. Once started, the call was taken up and repeated two

[1] These are described from fresh specimens by Dr. Gaumer (Trans. Kans. Acad. Sci., VIII, 1883, p. 60) as follows: "There are twenty-four fleshy processes arranged in two rows on the front part of the neck, and about twenty more of the same kind form two rows over the head; many smaller ones are scattered over the head. At the point of union of the bill with the head, there is a long fleshy process capable of much erection and distension. Behind this the fleshy scalp is permanently elevated so as to form a flat topped pyramid, with its greatest length from bill to occiput." (See also plate of head in P. Z. S., 1861, pl. xl.)

[2] αγριος, wild. χάρις, grace.

or three times by pair after pair, and beginning thus far off it would gradually draw nearer and then pass into the distance, not to be heard again that day.

At the time of my visit Chachalaccas were feeding on the ripening fruit of the sapote or sapodillo. This they ate while it was still attached to the twig from which it grew and also after it had fallen. They are, however, arboreal rather than terrestrial, and pass by far the greater part of their time in the trees. Here they are very active, craning their neck from side to side, raising their crest and flirting their tail. When on the wing they do not appear to advantage, and with outstretched neck flap heavily and then sail a short distance.

73. **Colinus nigrogularis** (*Gould*). YUCATAN BOB-WHITE.—Abundant; resembling in notes and habits *Colinus virginianus*. It was exceedingly interesting to hear Bob-whites so unlike our *virginianus* in appearance singing and calling in a manner so nearly like our northern species that the casual listener would appreciate no difference in the voice of the two birds, though the voice of the Yucatan bird is not so loud as that of *C. virginianus*. This observation, in connection with Lieutenant Robinson's description of the notes of *Eupsychortyx sonninii*, which he states are like those of *C. virginianus*, suggests that the calls of these birds are older than the birds themselves, and that they have been inherited from a common ancestor.

74. **Ardea herodias** *Linn.* GREAT BLUE HERON.—The only water bird observed at Chichen was a Great Blue Heron, which was seen at a cenote, March 19.

LIST OF PRINCIPAL PAPERS RELATING TO YUCATAN BIRDS.

1843. CABOT, S., JR. (?)—Memorandum for the Ornithology of Yucatan. *Incidents of Travel in Yucatan*. By John L. Stephens. Harper Brothers, New York City. Vol. II, pp. 469–476.

1845. CABOT, S., JR.—Further Account of Some of the Birds of Yucatan. *Journ. Bost. Soc. Nat. Hist.*, V, pp. 90–93, pl. xii.

1852. SCLATER, P. L.—Ornithological Observations. IX. On Birds from Yucatan described by Dr. Cabot in the Journal of the Boston Natural History Society. *Jard. Contrib. Orn.*, 1852, p. 96.

1869. Lawrence, G. N.—List of a Collection of Birds from Northern Yucatan. *Ann. Lyc. Nat. Hist. New York*, IX, 1869, pp. 198–210.

1881. Nehrkorn, A. — Beschreibung yucatanischer Eier. *Journ. für Orn.*, 1881, pp. 65–69.

1882. Lawrence, G. N.—Description of a New Species of Swift of the genus *Chætura*, with Notes on two other little-known Birds. *Ann. N. Y. Acad. Sci.*, II, 1882, pp. 245–248.

1882. Lawrence, G. N.—Description of two New Birds from Yucatan, of the families Columbidæ and Formicariidæ. *Ann. N. Y. Acad. Sci.*, II, 1888, pp. 287, 288.

1883. Boucard, A.—On a Collection of Birds from Yucatan. With Notes by Osbert Salvin. *P. Z. S.*, 1883, pp, 434–462.

Based on Dr. Gaumer's collections and observations, and by far the most important publication relating to the birds of the peninsula of Yucatan.

1883. Gaumer, G. F.—Notes on *Meleagris ocellata* Cuvier. *Trans. Kans. Acad. of Sci.*, VIII, 1883, pp. 60–62.

1883. Gaumer, G. F.—Notes on the Habits of Certain Momotidæ. *Trans. Kans. Acad. of Sci.*, VIII, 1883, pp. 63–66.

1885. Lawrence, G. N.—Descriptions of Supposed New Birds of the Families Tyrannidæ, Cypselidæ and Columbidæ. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 156–158.

1885. Lawrence, G. N.—Description of a New Species of Bird of the genus *Engyptila*, with Notes on Two Yucatan Birds. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 271–273.

1885. Lawrence, G. N.—Characters of Two Supposed New Species of Birds from Yucatan. *Ann. N. Y. Acad. Sci.*, III, 1885, pp. 273, 274.

1885. Ridgway, R.—Descriptions of Some New Species of Birds from Cozumel Island, Yucatan. *Proc. Biol. Soc. of Washington*, III, 1885, pp. 21–24.

1885. Salvin, O.—On a Collection of Birds from the Island of Cozumel. *Ibis*, 1885, pp. 185–194, 1 pl.

1885. Ridgway, R.—Catalogue of a Collection of Birds made on the Island of Cozumel, Yucatan, by the Naturalists of U. S. Fish Commission Steamer 'Albatross,' Capt. Z. L. Tanner, Commander. *Proc. U. S. Nat. Mus.*, VIII, 1885, pp. 560–583.

1888–90. Salvin, O.—A List of the Birds of the Islands of the Coast of Yucatan and Bay of Honduras. *Ibis*, 1888, pp. 241–265; 1889, pp. 359–379; 1890, pp. 84–95.

1890. Stone, W.—On Birds Collected in Yucatan and Southern Mexico. *Proc. Acad. Nat. Sci. Phila.*, 1890, pp. 201–218.

Article XIX.—TRANSFORMATIONS OF SOME NORTH AMERICAN HAWK-MOTHS.

By WILLIAM BEUTENMÜLLER.

The following notes on transformation of some Sphingidæ were made during the past summer, and nearly all the eggs were received through the kindness of Mr. Jacob Doll.

Sphinx drupiferarum *A. & S.*

Egg.—Oval, longer than broad, pale whitish green, smooth. Length, 1.5 mm.; width, 1.25 mm.; height, 1 mm. Laid June 11; emerged June 16. Length of young larva, 2 mm.

Stage I.—Head globular, smooth. Wholly pale whitish with a faint trace of a greenish tinge and no traces of the characteristic oblique bands on each side. Caudal horn rather long, black. Under the lens the larva is regularly transversely wrinkled, and as it grows older, faint traces of a whitish subdorsal stripe appears. Length, 8 mm.; caudal horn, 2 mm. Moulted June 22.

Stage II.—Head finely granulated. Body pale green along the sides and whitish along the dorsal region. Along each side is a fine whitish subdorsal line and oblique stripes along the sides. Caudal horn reddish. Legs green, with black tips; thoracic feet pinkish. The subdorsal line, as the larva grows older, becomes broken and is quite indistinct. Length, 18 mm. Moulted June 27.

Stage III.—The body is now apple green, the caudal horn redder, and the oblique stripes more distinct—whitish in the middle, greenish at each end and carmine red in front. Body and head rather strongly granulated. In some individuals the red on the oblique stripe is absent. Length, 30 mm. Moulted July 2.

Stage IV.—Body green, granulated, with the oblique stripes on each side pure white, with violet in front. Thoracic feet pink, yellow at their bases. Length, 43 mm. Moulted July 6.

Stage V.—Head large, rugose, green, with a broad russian leather red stripe on each side. Body smooth, without granulations, pale pea green, darker at the extreme sides and beneath; the oblique stripes are broad, bright violet-purple in front and narrowly white behind. Caudal horn russian leather red. Thoracic feet russian leather red, with their basal halves yellow. Spiracles pale orange. Abdominal legs green, extremities black and preceded by a narrow yellow ring. Mouth parts black. Length, 80–85 mm. Fully grown, July 14–17. Formed pupæ July 18 and 21.

Pupa.—Rather large and stout, pitchy brown, segments rugosely punctured, junctions of segments dull, exceedingly finely and regularly wrinkled. Thorax and head rugose, wing-cases slightly rugose. Tongue-case closely applied to to the chest. Length, 50–52 mm.; width, 13 mm.; tongue-case, 10 mm.

The eggs were received from Mr. J. Doll, who found them on Long Island on wild cherry (*Prunus serotina*). The young larvæ, however, would not eat the leaves of this tree, and they all died. Another lot of eggs were sent me by Mr. Doll, and they were fed and raised to maturity on a species of cultivated Japanese cherry, on which they thrived very well. Mr. Doll informs me that he was likewise unable to raise his larvæ of *drupiferarum* on *Prunus serotina.* They also feed on beach plum (*Prunus maritima*), cultivated plum and cherry, and are said to also feed on hackberry (*Celtis occidentalis*). I have found the eggs on *Prunus pennsylvanicus.* My larvæ also refused to eat the leaves of cultivated apple.

Sphinx lucitiosa *Clem.*

Egg.—Globular, smooth, shining, pale green, slightly longer than broad. Length, 1.25 mm.; width, 1 mm.; height, 1 mm. Laid June 4; emerged June 9. Length of young larva, 1.5 mm.

Stage I.—Wholly pale yellowish white, without any marking whatever. Caudal horn black. As the larva grows older it is regularly covered with transverse rows of minute white dots, and on each side is a very narrow white subdorsal stripe. Length, 7 mm. Moulted June 15.

Stage II.—Head globular, with numerous fine granulations. Body granulated, pale green along the sides, whitish green along the dorsal region, and a subdorsal stripe on each side. Abdominal and thoracic feet green. Along each side are faint traces of oblique bands composed of granulations. Caudal horn black. Length, 14 mm. Moulted June 20.

Stage III.—Head as in the previous stage, but with a yellow stripe on each side. Body with numerous yellow granulations and a yellow subdorsal stripe running from the head to the end of the third segment. The oblique lateral bands are yellow and very distinct. Dorsal region paler green than the sides of the body. Caudal horn brownish on top, yellowish at sides and beneath. Length, 18 mm. Moulted June 23.

Stage IV.—Similar to the last stage, but the caudal horn is much stouter and pale greenish with a pinkish tinge or is wholly green. The oblique lateral bands are yellow behind, whitish in the middle and pink in front. Head with a broad, bright yellow stripe on each side, and on the body is a short, yellow, subdorsal stripe on the anterior segments. Thoracic feet yellowish at base, claret red at tip. Body bright yellowish green, paler along the back. Length, 33 mm. Moulted June 29.

Stage V.—Head smooth, with a broad yellow stripe on each side in front. Thoracic feet yellow and tipped with red. Body bright yellowish green, entirely smooth, the granulations being reduced to yellowish dots. On the second and third segments there are many white dots encircled with black. The oblique lateral bands are finely black in front, carmine red in the middle and white behind. The white on the last band reaches to the base of the caudal horn, which is green, with a broad black stripe on each side. When fully grown the larva becomes apple green, smooth and darker on the first, second and third segments. The oblique bands lose the black on the anterior part, and they are bright carmine red in front and clear white behind. The head is somewhat rugose, apple green, with the yellow stripe on each side pale green. The thoracic feet are pale yellow at base and cherry red at their tips. Anal and abdominal legs wholly green. Spiracles pale orange. In some individuals the carmine of the lateral bands is inclined to be purplish. Length, 60 mm. Fully fed July 9, 11 and 13. Head, 5.5 mm. wide; 5.75 mm. high.

Pupa.—Rather small, pitchy brown, rugosely punctured and wrinkled. Tongue-case very short, slightly curved or straight. Projection on last segment rather long and stout at base, sharply pointed at tip with two very small spines. Length, 34 mm.; width, 10 mm.; tongue-case, 3 mm.; anal projection, 4 mm.

The eggs were received from Mr. J. Doll. They were found on the leaves of willow (*Salix discolor?*), and it is possible that they will also feed on other species of willow. My larvæ were raised on Lombardy poplar.

Sphinx kalmiæ *A. & S.*

Egg.—Oval, smooth, pale semitranslucent whitish green. Laid June 22. Emerged June 28, 1896. Length of young larva, 1.5 mm.

Stage I.—Wholly pale whitish. Caudal horn black. As it grows older the body becomes greenish and there appear faint traces of a whitish subdorsal line on each side. Length, 12 mm.

Stage II.—Greener than in the last stage, with a fine white subdorsal stripe and fine white oblique lateral bands. Head and body finely granulated. Caudal horn black, with short black bristles, like spines at the tip. Body along the back whitish green, somewhat darker green along the sides. Legs and feet wholly green. Length, 18 mm. Moulted July 5 and 6.

Stage III.—The head is now bright apple green, with a yellow stripe on each side. The body is also bright apple green at the sides and beneath; along the dorsal region, pale whitish green. Caudal horn bluish, with short black spines. The oblique bands are now blue black in front, white in the middle and yellow behind. The granulations on the anterior segments are more numerous than on the sides. Length, 22–25 mm. Moulted July 7 and 8.

Stage IV.—Head with a yellow or yellow and black stripe on each side. The body is now much smoother than in the preceding stage, and the oblique bands are sky blue in front, white in the middle and yellow behind, the yellow of the last band, running to the base of the caudal horn, which is blue at the basal half on top, yellowish green beneath, and outer half jet black, with black spines. Thoracic feet black, white at their bases, with a narrow black ring. Abdominal and anal legs green. Anal plates with black granulations. Length, 36 mm. Moulted July 10, 11, 12 and 13.

Stage V.—Body now entirely smooth and without granulations, bright green, and much paler along the back than along the sides. Head rather small, with a broad jet black stripe on each side and a light yellowish green one before the black one. The oblique lateral bands are now broadly jet black, finely white along the middle and broadly canary yellow behind. Caudal horn blue, with jet black granulations. Spiracles pale orange. Thoracic feet black, with a bluish ring at their bases. Abdominal legs green inside, with a jet black band outside at the base and at the extremities, and yellowish green between. Anal plates with black granulations; extremities black. Length, when fully grown, 65 mm. Stopped feeding July 14–18. Formed pupæ July 16, 18, 19, 20 and 21. Moths emerged August 1, 3, 4, 5, 6 and 7.

Pupa.—Deep chestnut brown, wing-cases and thorax pitchy brown, as are also the leg-cases, which are streaked at their junction with light chestnut color. Tongue-case slightly curved, stout, about one-third the length of the wing-cases. Anal projection rather short. Length, 42 mm.; width, 11 mm.; tongue-case, 8 mm.; anal projection, 2 mm.

The eggs were obtained from a female collected at light at Greenwood Lake, New Jersey, and the larvæ were raised on lilac. They also feed on laurel, ash, privet and *Chionanthus*.

Sphinx plebeius *Fabr.*

Egg.—Pale green, smooth, shining, very slightly longer than broad. Length, 1.2 mm.; width, 1 mm.; height, .75 mm. Emerged July 15. Length of young larva, 1.5 mm.

Stage I.—Wholly pale shining green, with a subdorsal stripe of a whitish color along each side, and a finer one along the extreme sides. Head minutely granulate. Length, 12 mm. Moulted July 19.

Stage II.—Head and body regularly granulated; body apple green above, bluish green at the extreme sides and underneath. The oblique lateral bands are yellowish white, and the subdorsal stripe yellow and composed of granulations from the anterior edge of the first segment to the end of the third segment. Caudal horn rather long, bluish above, greenish at the sides and beneath, and with a few blackish points. Length, 22 mm. Moulted July 21.

Stage III.—Body above apple green laterally, and beneath blue green, finely granulated; with the short granulated subdorsal stripe as in the last stage. The oblique lateral bands are yellowish green and whitish green as they enter the paler color on the dorsal region, and whitish in the bluish green lateral portion of the body. First three segments above and below apple green, as also are the thoracic feet. Abdominal and anal legs blue green. Caudal horn bluish with the tip green. Spiracles orange. Length, 35 mm. Moulted July 24 and 25.

Stage IV.—The dorsal region of the body is now bright yellowish green and the sides and underneath bluish green, standing in strong contrast to the color along the dorsal region. The oblique bands are yellow as they enter into the yellowish green color on the back, and whitish green at the sides. Caudal horn bluish lead color. Body dotted with yellow granular dots at the sides and beneath with whitish. First three segments wholly green, with a subdorsal line composed of yellow granular dots. Head globose, with greenish white granules. Spiracles cream color, black at each side. At the sides of the body behind each oblique band on the bluish green lateral parts is a triangular bluish flush. In mature larvæ the caudal horn is decidedly blue, yellowish green on top, with yellow granules. Length, 68 mm. Entered the ground to pupate July 28 and 30. Formed pupæ July 31 and Aug. 2.

Pupa.—Bright shining chestnut brown, finely punctured. Tongue-case long, slender, straight and closely applied to the chest. Anal projection sharp, rather short, with two minute spines at tip. Length, 40 mm.; width, 11 mm.; tongue-case, 13 mm.; anal projection, 1.5 mm.

The eggs were received from Mr. J. Doll. The larvæ were fed on trumpet vine (*Tacoma radicans*), which seems to be, as far as we know at present, its only food-plant. They passed through only three moults, instead of four or five, as is usually the case with other Sphingid larvæ. They fed very rapidly, it taking but sixteen days to reach maturity.

Ceratomia undulosa (*Walker*).

Egg.—Pale green, smooth, shining, longer than broad. Length, 1.5 mm.; width, 1.25 mm.; height, 1 mm. Laid June 8. Emerged June 13.

Stage I.—Head subtriangular. Wholly pale green, with a narrow, pale yellow subdorsal stripe along each side of the body. Caudal horn pale brown. Length, 10 mm. Moulted June 18 and 19.

Stage II.—Pale green; body transversely wrinkled, with the subdorsal yellow stripe broader and more distinct than in the previous stage. Caudal horn reddish black. Head granulated, with an indistinct yellow stripe on each side. Length, 15 mm.; caudal horn, 3 mm. Moulted June 20 and 21.

Stage III.—In this stage the subdorsal stripe is very conspicuous, being clear yellow and quite broad. The stripe on each side of the head is also broad and clear yellow. Along each side of the body are seven yellow, oblique bands, which become white as they reach the subdorsal stripe. In some individuals there is a row of red spots along each side, one spot on each segment, situated on the subdorsal stripe from the fourth to the tenth segment inclusive. On the stripe of the head is also a red spot. Spiracles orange. Caudal horn long and stout, reddish, with very short spines. The body color is yellowish green above and brighter green beneath. As the larvæ grow older the subdorsal stripe becomes broken by the oblique lateral bands, which are then very distinct and conspicuous. Length, 23 mm.; caudal horn, 4 mm. Moulted June 25 and 26.

Stage IV.—Head subtriangular, almost smooth, with the stripe on each side broad. Anterior segments of the body with a few granulations; sides of body pale green; dorsal region yellowish green, with regular transverse wrinkles which are yellowish. The oblique bands are very distinct and quite broad, white at the middle, yellow at each end, and with a claret red streak on the anterior part of each; in some specimens the red is absent, and in others there is a large carmine blotch before each oblique band, and one on the head on the yellow stripe. The last oblique stripe is very broad and does not run to the end of the caudal horn, as is the case with some species of Sphingid larvæ. Caudal horn is either rose red or pale violet with fine black granules. Length, 35 mm. Moulted June 29 and 30.

Stage V.—The larva is now entirely smooth, except the anal plates, which are finely granulated with black. The stripes on the head are now white instead of yellow. Body at the sides uniformly blue green, dorsal region yellowish green and transversely wrinkled. Spiracles large and conspicuous, white centrally and orange red outside. The oblique bands are conspicuously white and broad, and in some individuals reddish in front. Caudal horn pinkish. Thoracic feet pink, paler at the base. When fully grown the larvæ become grayish green along the sides and beneath, and remain yellowish green along the back. The stripes on the head become whitish flesh-color. The oblique lateral bands are whitish and yellow as they run into the reddish green color on the back. Caudal horn pinkish at the sides. Some individuals of the brood have the back very bright yellowish green ; the head lilac with the stripes decidedly flesh-color, and before each oblique band is a large ferrugineous patch. Abdominal legs outside pinkish. Fully grown July 5–6. Length, 65 mm. Entered the ground for pupation July 6–7, and formed pupa July 9–11. Moths emerged July 22–23.

Pupa.—Dark chestnut brown, shining, without a tongue-case ; anal projection rather short ; segments punctured ; wing-cases smooth. Length, 45 mm.

The eggs were obtained from a female collected in Hoboken, New Jersey, by Mr. W. Sachs, and the larvæ were raised on lilac. They also feed on ash and privet (*Ligustrum*), and are double brooded. Mr. Sachs informs me that one larva of the brood he raised was entirely ferrugineous.

Smerinthus myops (*A. & S.*).

Egg.—Pale green, smooth, shining, longer than broad. Length, 1 mm.; width, .75 mm. Laid June 3. Emerged June 10.

Stage I.—Pale green, covered with short, pale sordid white hairs. Caudal horn green. Head globular and granulated. Length, 7 mm. Moulted June 15.

Stage II.—Head triangular with the granules larger, and along each side of the body is a short yellowish green subdorsal stripe running from the head to the end of the fourth segment ; along the sides are also oblique yellowish green bands. Legs green ; thoracic feet pink ; caudal horn red. Length, 14 mm. Moulted June 20.

Stage III.—Body yellowish green, head decidedly triangular and forming a tubercular process at the apex, granulations canary yellow, as are also those on the body. The short subdorsal stripe is composed of granular serrations ; lateral oblique yellow bands distinct. Thoracic feet red. Caudal horn red with indications of the last oblique band at the sides. One specimen has a red spot on each side of the second and fifth segments. Length, 18 mm. Moulted June 24.

Stage IV.—Very much like the last stage, but the last oblique lateral band is clear yellow and runs to the end of the caudal horn, which is now entirely yellow. Length, 27 mm. Moulted June 28.

Stage V.—The body is now bright yellowish green above and below, covered with fine yellow granulations ; the last oblique band is much brighter yellow and broader than the rest, and runs to the end of the caudal horn. Head triangular with the tubercles on the vertex much reduced. Spiracles white in the centre and red outside. Length, 40 mm. Fully grown July 5.

Pupa.—Similar to that of *S. excæcatus* and *S. geminatus*, but much smaller and more glossy. Segments rugosely punctured and shining, junctions of segment opaque. Wing-cases smooth and very shining. Tongue-case absent. Anal projections short. Length, 25-30 mm ; width, 8-9 mm.

The eggs were received from Mr. J. Doll, and the larvæ were raised on wild cherry (*Prunus serotina*). As compared with *S. geminatus* and *excæcatus* the larva of *S. myops* differ from these by having the granulations on the body much finer, and the short subdorsal stripe on the anterior segments quite indistinct, while in *geminatus* and *excæcatus* this stripe is composed of prominent serrations. The lateral oblique bands of *myops* are also fainter.

Article XX.—NOTICE AND DESCRIPTION OF NEW SPECIES AND A NEW GENUS OF PHYLLOCARIDÆ.

By R. P. Whitfield.

Plates XII–XIV.

Mr. Edgar E. Teller and Mr. Charles E. Monroe, of Milwaukee, Wisconsin, have placed in my hands a collection of remains of Ceratiocaris-like Crustaceans, for determination and description, which they obtained near Waubeka, Wisconsin. The quarries in which these specimens were found are situated about one mile north of the village, near the Milwaukee River, and are described in Volume II of the Geological Survey of Wisconsin, where they are referred to the Lower Helderberg formation. The remains are found in the present bed of the quarry in a layer used for building-stone and flagging, and seem to be fairly numerous, judging from the number of fragments obtained.

In studying these fossils I find among them representatives of three distinct forms. One of these, and by far the most abundant, belongs to the genus *Ceratiocaris*, so far as the general form and features are concerned, while one other differs considerably in the form of the carapace and appears to belong to a distinct genus, for which I propose the name Entomocaris, from the resemblance of the carapace to that of an ostracode entomostracan, since it is strongly curved in front and behind on the dorsal margin, instead of being nearly or quite straight, as in *Ceratiocaris*. This renders it probable that there was a hiatus between the two sides of the carapace both in front and behind. The posterior margin was not truncated as in *Ceratiocaris*, but obtusely rounded, more as in *Colpocaris* M. & W., and *Rhinocaris* Clarke, indicating a bivalved carapace.

Entomocaris,[1] new genus.

Carapace ovate in outline, bivalvular, with a strong hiatus in front and rounded behind; hinge line straight for about half its length. Rostrum not

[1] ἔντομος, cut up; καρίς, a shrimp.

known. Abdomen composed of fourteen or more segments, three or four of which may be naked. The post-abdomen bears three spines, the central one or telson, elongate and slender, and the lateral ones (*cercopods*) flattened and articulated to the caudal plate.

Entomocaris telleri, n. sp.

PLATE XII, FIG. 1, AND PLATE XIV, FIGS. 1, 2 AND 7.

Specimens of more than medium size, the only entire individual seen measuring about twenty-one centimeters in length by six and one-half centimeters dorso-ventrally across the carapace.

Carapace ovate in general outline, straightened on the middle portion of the dorsal margin and gibbously rounded on the ventral; widest a little behind the middle of the length; antero-dorsal margin rather strongly curved for three and one-half centimeters from the anterior end, which is marked by a narrow, sharp beak half a centimeter long; on the postero-dorsal margin the border is more abruptly rounded and margined by a narrow, thickened border which extends entirely around the ventral portion to the base of the anterior beak; surface marked by very fine, wavy striæ, much too fine and faint for representation on the figures.

Abdomen much elongated, composed of fourteen or more segments. The anterior ones within the limits of the carapace must have been quite short, but their outlines cannot be seen, and their presence and number are only shown by the indications of slender limbs (swimmerets) as seen pushing up the crust of the carapace which overlies them. Farther back the segments are more distinct. The terminal segment is long, about one-fourth longer than high. Surface of the body segments granulose, so far as can be seen by a good lens; no other marking being visible.

Telson moderately large; spine straight and slender, as long as the last four and a half body segments; thickened in the middle as it lies flattened on the rock, leaving a deep median depression in the matrix where removed. Lateral spines strong and thickened on the margins, the entire length not indicated on the stone, from the breakage of the surface.

The swimmerets seem to have been slender, judging from indications left on the specimen.

Mandibles very imperfectly represented. An indication of their existence is seen in the elevation of the crust of the carapace, but with considerable uncertainty. The mandibles shown on Plate XIV, Figs. 1 and 2, have been referred with some doubt to this species, principally on account of their greater strength and the difference in form from those preserved in the specimens of *Ceratiocaris monroei*. These are somewhat triangular, and are provided with five strong cusps of much the same form as those of the species just mentioned, but the manubrium is quite different in its detail, especially in the large triangular opening in the inner surface for the passage of the muscular parts.

This species differs from *Certiocaris monroei*, with which it is associated, principally in the form of the carapace, which is rounded posteriorly instead of being obliquely truncated, and has the dorsal line rounded in front of and behind the proportionally shorter hinge line. It also differs in the absence of the peculiar surface structure of the .body segments and in the form of the lateral appendages of the tail, which are provided with thickened margins in this species, whereas those of the best preserved example of that species are flattened and smooth, or at most have an impressed line of minute punctures which may represent the bases of a row of fine setæ.

Ceratiocaris monroei, n. sp.

PLATE XIII, FIGS. 1–5, AND PLATE XIV, FIGS. 3–8.

Specimens of moderately large size. Carapace of semielliptical form, about three-fifths as high as long ; dorsal line very nearly straight, anterior extremity slightly beaked, posterior end obliquely truncated, longer below than above, with the truncation a little more than half the height ; ventral margin irregularly rounded, more gibbous in the middle or just anterior to the middle of its length ; margin thickened, forming a narrow flat border which extends from the rostrum in front to the posterior basal angle, which is rounded ; surface of the crust very finely and evenly striated, the striæ passing obliquely downward and forward from the dorsal line and nearly parallel to the basal margin and again upward toward the anterior end. The striæ number from twelve to fifteen in the space of one millimeter ; substance of the carapace very thin ; ocular tubercle not positively observed.

Abdomen composed of about fourteen segments, those within the carapace short and slender, enlarging backward in both length and width until their width (or height) is more than half the dorso-ventral height of the carapace ; four or more segments apparently exposed beyond the posterior margin of the carapace ; the last segment long, twice or more than twice as long as that in front, and rapidly narrowed backward to the junction with the telson.

Telson long and slender, and when flattened from the side is seen to have been slightly recurved and probably somewhat triangular in section, but evidently marked by a thickened central rib which shows convex both on the substance and in the impression of the opposite side of the same individual. It is also armed with a thin, flattened, slightly recurved, lanceolate appendage or lateral spine (*cercopod*) on each side, articulated just behind the articulation of the caudal plate, and of about half or less than half the length of the central spine. These appendages are usually destitute of any ornamentation, but in one or two cases show a line of fine punctures near the upper margin, while the central spine shows a row of minute punctures on each side, and in some cases rows of hair-like spines.

Mandibles rather large and strong, somewhat hatchet-shaped and armed with five or six protuberances near the masticating edge. The upper or outer surface appears to have been smooth and flat. On the inner face they are thickened near the margin for the teeth, and behind these an oval opening is seen which extends to near the posterior margin, probably for the passage of the motor ligament.

Surface of the abdominal rings marked by wavy lines toward the sides and below, and above the median line passing into a peculiar tessellated structure composed of zigzag lines and punctures.

Several of the specimens showing the abdominal segments retain portions of the swimming feet or imprints of them. None of them, however, are sufficiently well preserved to show an entire limb satisfactorily. There appears to have been one pair to each segment, and the limbs seem to have decreased slightly in length and thickness from the larger segments backward, and much more rapidly from the same point forward, as seen on several specimens. These limbs (*swimmerets*) appear to be composed of the three outer joints only, those nearer the body not being distinguishable. The outer joint seems to be flattened, and in one or more specimens appears to have been margined with fine setæ.

On two of the abdomens preserved, there is seen an impression running along the central line and extending from near the anterior end of the body backward, terminating just in front of the telson near the ventral margin. This I presume to have been the intestinal canal. In one of the specimens it is deeply and strongly marked, and appears as if it had been undulated by numerous constrictions; in another it looks as if transversely corrugated. If it is the imprint of the intestinal canal, it was probably distended with food when the animal died, since the impression left is quite strong.

This species differs from *C. maccoyana* and *C. aculeata* Hall, from the Water-lime formation of New York (Pal. N. Y., Vol. III, pp. 421*, 422*, Pl. 84, Figs. 1–6) in the shorter form of the carapace and in the entirely different proportions of the spines of the tail, the *cercopods* in that species being very nearly as long as the telson, while in this one they are only about half as long.

Ceratiocaris poduriformis, n. sp.

PLATE XIV, FIG. 10.

Carapace unknown. Abdomen very small, sublinear and elongate-cylindrical; segments, of which only four are known, proportionally long and narrow, the last one rather more than twice as long as thick, and very slightly tapering ; the second one as long as high, and the two in front higher than long ; articulating margins oblique.

Telson as long as two and a half of the body segments, counting from behind ; central spine slender and its appendages about half its length.

Surface, as seen on some of the crust preserved in the matrix, marked by slightly oblique, somewhat wavy striæ.

This specimen appeared so doubtful at first that I scarcely considered it as belonging to the genus, but on further examination I thought it might be an articulated rostrum of one of the species, if they really were provided with such an appendage. With this idea in mind I placed the specimen under a higher magnifying power to examine the crust, which is partly preserved in the matrix, when I found that there was a caudal appendage, mostly covered by adhering rock. This I subsequently uncovered to its entire length, revealing the articulated appendages and proving the specimen to be in fact a small *Ceratiocaris.* It can hardly be the young of either of the species with which it is associated, on account of the difference in the proportion of the length and height of the segments, and I have considered it a distinct species, as was originally suggested to me by Mr. Teller, the discoverer. The specific name applied will recall its resemblance to *Podura*, the 'skip-jack' or 'spring-tail.'

General Remarks.—The specimens of Phyllocaridæ found in the quarries mentioned at the beginning of this article are quite numerous, but consist mostly of the caudal spines and mandibles. A few imperfect bodies have been obtained, and also a few preserving more or less of the carapace. A single almost entire individual of *Entomocaris telleri* was obtained and is figured on Plate XII. It is also probable that some of the caudal spines and some of the mandibles found belong to that species, but it is quite impossible at the present time to decide with any degree of certainty to which of these species any of the detached fragments may have belonged. Among the mandibles there appear to be two quite different forms, one having a small oval or rounded opening on the under or inner surface, and the other presenting a much larger, subtriangular opening. The latter form is usually the larger and stronger, hence I have inferred that it may belong to *E. telleri*, since the smaller, hatchet-shaped mandible with the round or oval foramen is often found connected with the examples of the carapaces of *C. monroei*.

The same difficulty arises in trying to determine to which of the species the detached caudal spines belong. The articulated appendages of the telson of *Entomocaris telleri*, however, have a thickened margin, while those found actually attached to the other species have not. This feature will be found something of a guide in placing them. Of the third species, *Ceratiocaris poduriformis*, there has been found only one specimen, that figured, and its counterpart, and it is probably a rare form.

Much credit is due to Mr. Teller and to Mr. Monroe for their care in collecting the many fragments of these obscure forms; and also for their great liberality in presenting to the American Museum of Natural History all the type specimens figured in this paper.

Article XXI.—THE CHAZY OF LAKE CHAMPLAIN.

By EZRA BRAINERD and HENRY M. SEELY.

We present in this article an account of three exposures of the Chazy formation along the shores of Lake Champlain. For the collecting of fossils and for detailed measurements these outcrops are more favorable than at Chazy[1] village, where the formation was first studied by Professors Emmons and Hall. The rocky shores of islands and promontories in the lake region are cleared of soil by the waves, the lake level is a convenient datum for measurements, and government charts furnish accurate outlines for mapping.

THE VALCOUR ISLAND SECTION.

By far the best exhibit of the Chazy formation is at Valcour Island and on the neighboring mainland, from Bluff Point to Port Jackson. It here attains its maximum thickness. The base of the formation is seen resting upon the yellow magnesian limestone at the top of the Calciferous, and may be traced upward in various exposures through 890 feet of strata, till its summit is seen underlying the Black River limestone.

The strata here measured are as follows, in ascending order :

Group A (Lower Chazy).

1. Gray or drab-colored sandstone, interstratified with thin (or sometimes thick) layers of slate, and with occasional thin layers of limestone at the base, containing *Camerella* (?) *costata* Bill .... 56 feet.

The slaty sandstone gradually passes into

2. Massive beds, made up of thin alternating layers of tough slate and of nodular limestone, containing undetermined species of *Orthis* and *Orthoceras* .... 82 "

[1] See paper, 'The Original Chazy Rocks,' American Geologist, Nov., 1888, Vol. II, p. 323.

3. Dark bluish-gray, somewhat impure limestone, in beds of variable thickness; often packed with *Orthis costalis* Hall, which occurs with more or less frequency through the whole mass. Other fossils are: *Lingula huronensis* Bill., *Harpes antiquatus* Bill., *Harpes ottawaënsis* Bill. (?), *Illænus arcturus* Hall (*I. bayfieldii* Bill.), *Lituites*, sp. (?)..110 feet.

4. Gray, tolerably pure limestone in beds 8 to 20 inches thick, separated by earthy seams, the bedding being uneven. Many layers consist of crinoidal fragments, largely of *Palæocystites tenuiradiatus* Hall. Near the middle of the mass, for a thickness of 10 feet, some of the fragments and small ovoid masses (*Bolboporites americanus* Bill.) are of a bright red color..............................90 "

Making for the total thickness of *A* ....338 feet.

Group B (*Middle Chazy*).

1. Impure, nodular limestone, containing *Maclurea magna* Leseuer....25 feet.

2. Gray, massive, pure limestone, abounding in crinoidal fragments....20 "

3. Bluish-black, thick-bedded limestone usually weathering so as to show pure nodular masses enveloped in a somewhat impure, lighter-colored matrix; everywhere characterized by *Maclurea magna*. Near the middle of this mass, for a thickness of about 30 feet, the fossils are silicified and of jet-black color. The more important, besides *Maclurea*, are species of *Strophomena*, *Orthis* and *Orthoceras*..210 "

4. Dark, compact, fine-grained limestone, with obscure bedding, weathering to a light gray. Fossils are infrequent, but at a single locality there were collected *Orthis perveta* Con., *Orthis platys* Bill., *Leptæna fasciata* Hall, *Asaphus canalis* Con., *Cheirurus polydorus* Bill., *Harpes*, sp. und., *Illænus incertus* Bill., *Lichas minganensis* Bill., *Sphærexochus parvus* Bill., and several undescribed species..20 "

5. Bluish-black limestone like number 3, but less pure, containing *Maclurea magna* Leseuer, *Orthis perveta* Con., *Strophomena incrassata* Hall, *Orthis disparilis* Con., or *O. porcia* Bill. ......75 "

Total thickness of *B*.............350 feet.

Group C (*Upper Chazy*).

1. Dove-colored compact limestone, in massive beds, containing a large species of *Orthoceras*; *Placoparia* (*Calymene*) *multicostata* Hall, *Solenopora compacta*; and a large *Bucania*....................60 feet.

2. Dark impure limestone, in thin beds, abounding in *Rhynchonella plena*; at the base a bed 4 or 5 feet thick is filled with various forms of *Monticulipora* or *Stenopora*.......................125 "

3. Tough, arenaceous magnesian limestone, passing into fine-grained sandstone.. 17 "

Total thickness of *C*............202 feet.

Aggregate thickness of the Chazy on Valcour Island......890 feet.

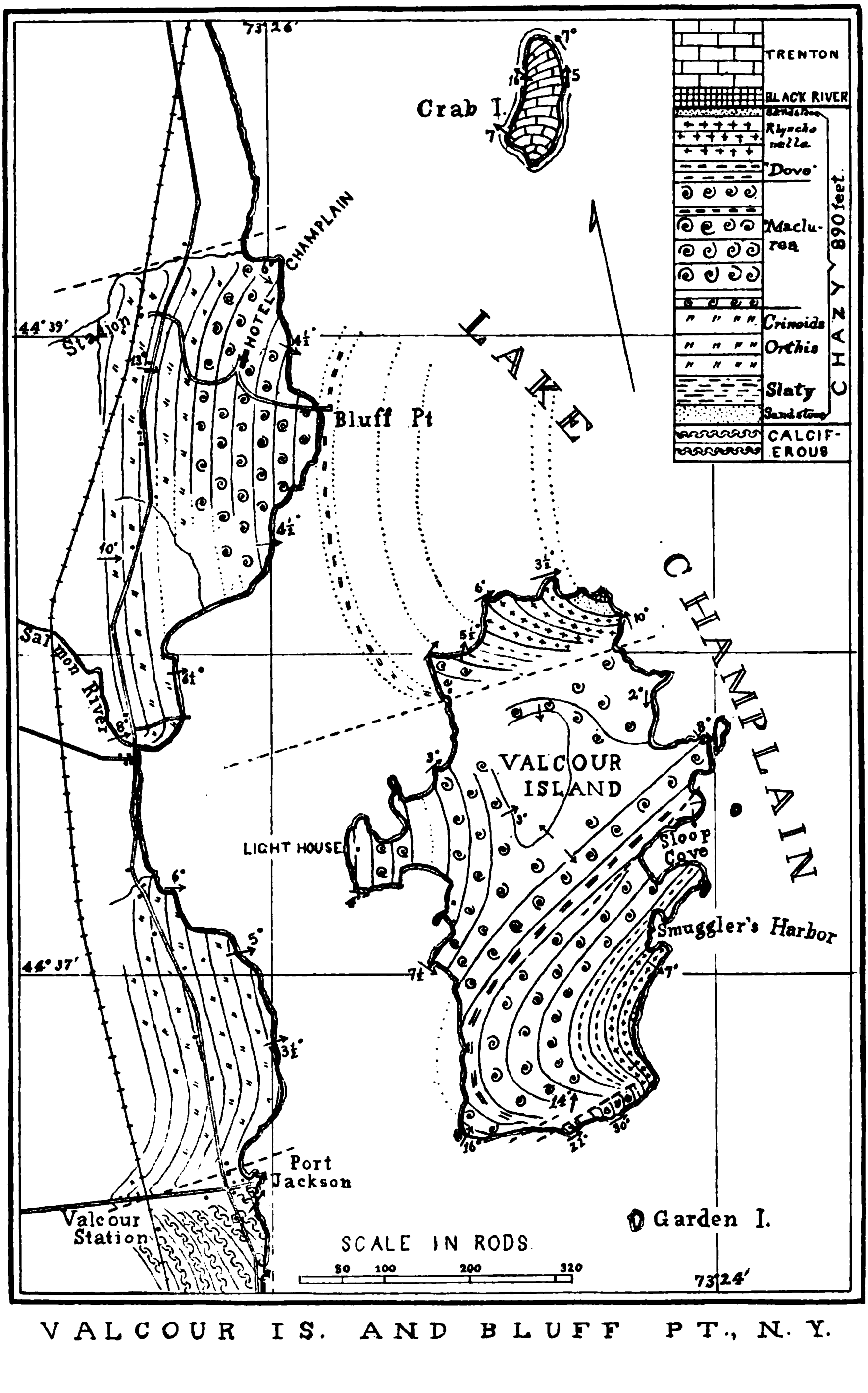
Valcour Island, which lies about six miles south of Plattsburgh, N. Y., is over two miles in length and one mile in width. Almost the entire shore is rocky, with deep bays and steep promontories, sometimes fifty feet in height. The strata slope for the most part eastward at an angle of from 3° to 7°; but a little north of the centre of the island there is a shallow syncline. Along the northwest shore of Sloop Cove is a minor fault, extending across the promontory north of the Cove. The excavation of the bay is doubtless due to this fault. Across the northern end of the island runs a greater fault, with an upthrow on the south side. The strata north of the fault dip to the northeast, the highest rock on the northeast point being the Black River limestone. Underneath, as we go westward, are seen the strata of *Group C*, Chazy, and the upper part of *Group B*.

At the south end of the island there is evidence of still greater disturbance. A fault with two branches runs in from the south shore to the northeast, but does not extend to the east shore. The rocks at the southeast are thus tilted to the east at an angle of from 22° to 30°, exposing the sandstone at the very base of the formation. The thickness of Chazy strata seen here is over 600 feet—in fact, the whole of the formation is exposed except the upper 80 feet and about 200 feet covered with soil. This hiatus of the upper part of *Group A* seems to have been caused by the removal by glacial action of the narrow mass of rock between the fault and the shore line. About one hundred rods southeast is a small rocky island, called Garden Island, consisting of the slaty strata of *Group A*, and lying in the strike of the same strata on Valcour Island.

If we turn our attention now to the mainland, we shall find the Chazy rock extending for three miles along the shore to the west of Valcour Island. It is terminated on the north by a transverse fault with an uplift on the south, as is indicated by a sudden westward curvature of the strike of the Chazy. North of this fault is a sand plain extending to the village of Plattsburgh. On the south also the Chazy uplift is terminated by a fault (another branch of the fault seen on the south side of Valcour Island), bringing up here the strata of the Calciferous. It is a noteworthy fact that all these principal faults, like those observed at Ticonderoga and elsewhere along the lake, consist of uplifts of the strata nearest to the neighboring Archean terrane. It is only four miles from Port Jackson south to the well-known display of Potsdam sandstone at the Ausable Chasm, and only six miles south to the Archean of Trembleau Point.

The strike of this outcrop of Chazy is quite uniformly north and south, with an eastern dip increasing as we go westward from 3° to 12°. It consists of the lower strata of the Chazy, though the sandstone at the base of the formation is not disclosed. The lowest rock seen is the slaty limestone (A, 2), well exposed in the bed of the Salmon River near its mouth. The remaining strata of *Group A* are displayed in long ledges lying on either side of the highway between Port Jackson and Plattsburgh. Especially favorable for the collecting of fossils are the old quarries and the broad fringe of sloping rocks along the shore for a mile north of Port Jackson. About fifty rods south of the Bluff Point Railway station are extensive quarries in the crinoidal beds of No. 5, A, from which a beautiful red-spotted marble is manufactured. As we go eastward from the station to the Hotel Champlain we pass rapidly over the lower Maclurea beds, till we reach the summit of the ridge on which the hotel is situated, 180 feet above the lake. The eastward slope, south of the driveway to the wharf, is with the strata, which here consist of the massive beds of No. 4, B, broken at the shore-line so as to form high cliffs. It is highly probable that the higher strata continue eastward under the waters of the lake, and are connected without a break with the exposures of the Upper Chazy at the north end of Valcour Island. We may also infer that the outcrop north of Port Jackson is continuous under the lake with the outcrop on the Light House promontory and the main body of Valcour Island. For the dip and strike on both sides of the channel are similar, and the strata here lacking have a thickness elsewhere which would nearly fill the gap between the island and the mainland.

Before closing our account of this interesting region, we would call attention to the fine outcrop of Trenton limestone at Crab Island, about a mile northeast of Bluff Point. The island is only 145 rods in length, but discloses over 200 feet of strata. As will



VALCOUR IS. AND BLUFF PT., N. Y.

be seen from the strike and dip indicated on the map, it is the remnant of a sharp anticline with an axis descending north-northeast. Strata in this attitude would offer the greatest possible resistance to glacial action, and this may account for the existence of the island.

Isle La Motte Section.

Our second map represents the outcrop of Chazy limestone at Isle La Motte, which lies about 14 miles to the north of Valcour Island. The strata appear on the south half of the island with a somewhat sinuous strike and dipping northward at an angle of from 3° to 5°. After 60 feet of Calciferous rock we have the following measures of the Chazy in ascending order:

Group A (Lower Chazy).

1. Layers of sandstone and slate containing *Lingula* and *Orthis*. . . . . 23 feet.
2. Silicious limestone with seams of tough slate containing *Camerella breviplicata* Bill., *Orthis porcia* Bill., *Strophomena aurora* Bill., *Strophomena camerata* Con., *Zygospira acutirostra* Hall, *Asaphus canalis* Con., *Cheirurus vulcanus* Bill., *Illæneus crassicauda* Wahl. (?), *Remipleurides schlotheimi* Bill. 55 "
3. Massive beds crowded with *Orthis costalis* Hall. . . . . 75 "
4. Crinoidal beds containing univalves and the layer of red-spotted marble; *Columnaria parva* Bill. occurs near the top. . . . . 70 "

Total exposure of *A*. . . . . 223 feet.

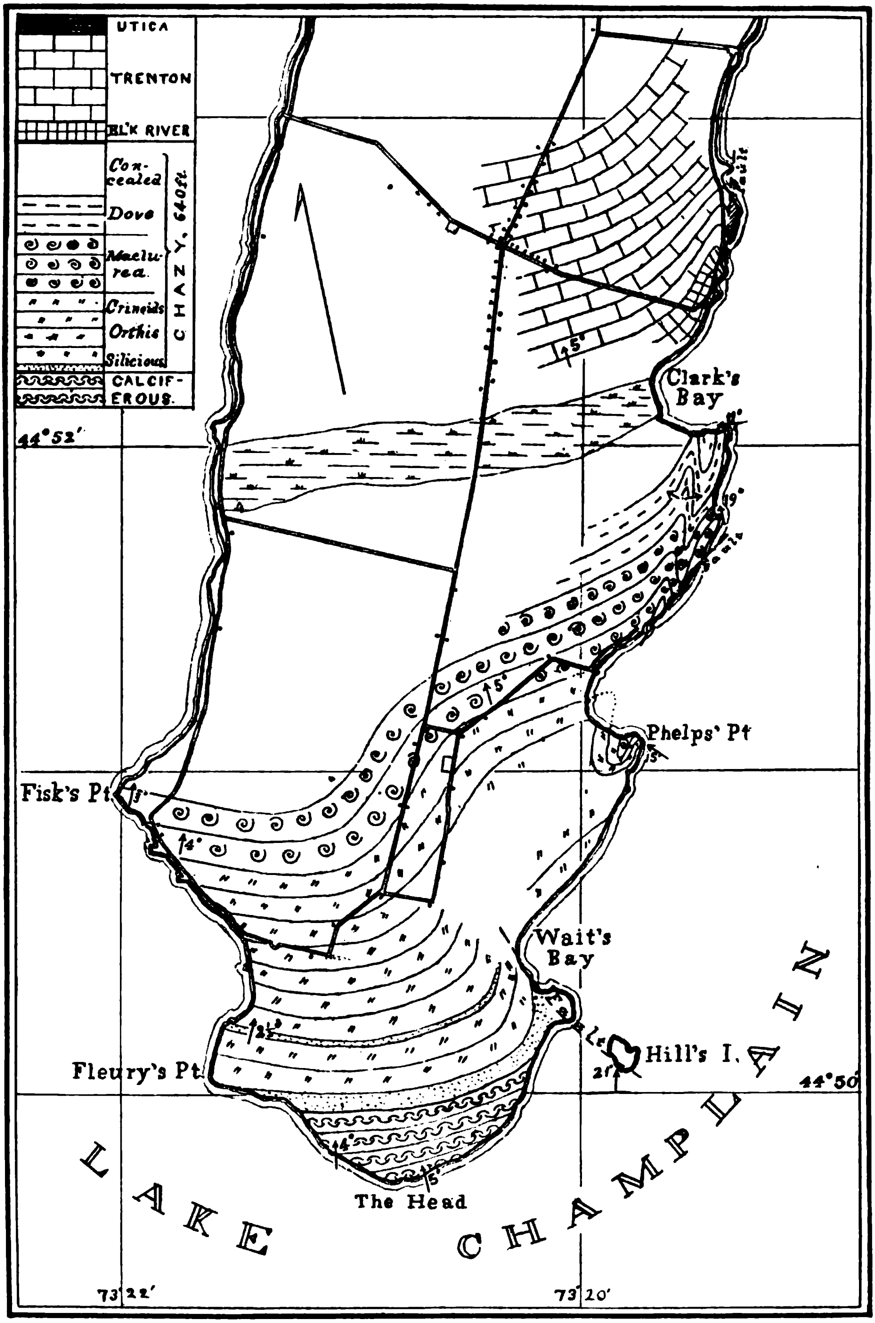
Group B (Middle Chazy).

Bluish-black, massive limestone like *B*, 3, at Valcour Island, containing *Maclurea magna* in abundance, and strata largely filled with *Stromatocerium*. The gray oölitic bed is found here at the base of the group, and the strata at the top are unusually massive, about 150 feet.

Group C (Upper Chazy).

1. Pure, fine-grained, dove-colored limestone with intercalated beds of silicious and dolomitic, iron-gray limestone, containing *Cyrtoceras boycii* Whitf., *Orthoceras titan* Hall, *Placoparia multicostata* Hall, *Lichas champlainensis* Whitf., and undescribed species of *Illænus* and *Bucania*. . . . . 120 feet.
2. Concealed. . . . . 150 "

Total thickness of Chazy at Isle La Motte. . . . . .643 feet.



ISLE LA MOTTE, VT

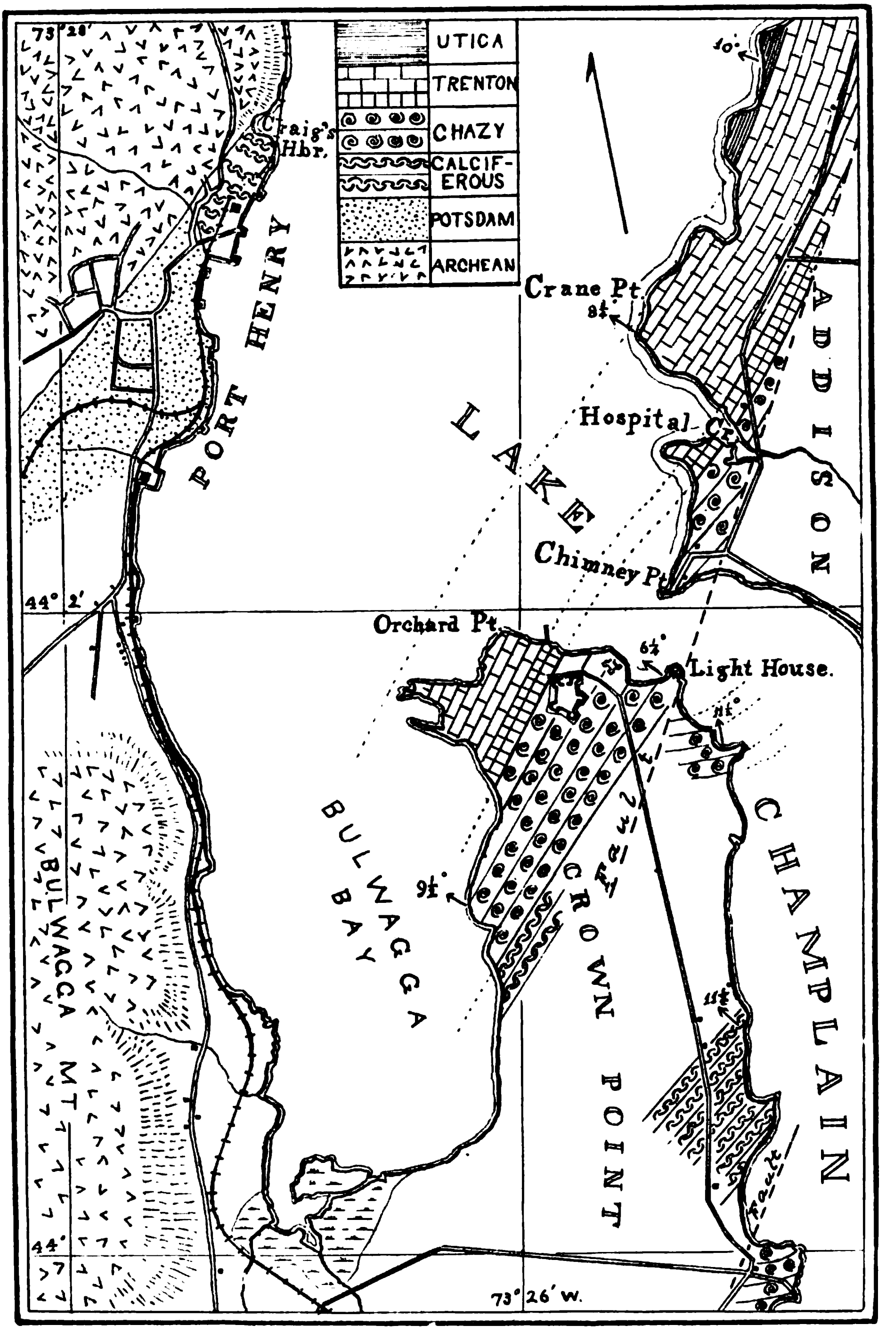
The south end of the island affords excellent opportunities for the study of the Lower Chazy. The rocks are well exposed along the shore, in the interior pastures of the headland (which rises about 100 feet above the lake), and in numerous quarries which have been extensively worked for over seventy-five years. In using the map for field work it should be remembered that the shading indicates the position of the strata on a horizontal plane at the level of the lake. Because of the small dip the exposures of these various strata at *elevated* points should be looked for farther south than indicated on the map.

The east shore of the island shows signs of great disturbance. A fault may be seen running from the head of Wait's Bay across the promontory on the south and farther southeastward across Hill's Island. Half a mile south of Clark's Bay the Utica slate is brought into contact with the Maclurea beds, which are here seen to have been abruptly folded, as is indicated on the map by the zigzag strike and the greatly increased dip. Two hundred rods to the north of Clark's Bay the Utica slate is again seen, but in contact with the Trenton limestone.

To the west of Clark's Bay the rocks have been eroded below the surface of the lake, and a wide marsh extends across the island. To the north of the marsh are seen beds of the Trenton, which may be traced to the east shore, where they are found to overlie the Black River limestone. Away from the shore the strike and the dip of the Trenton are uniform and identical with the strike and the dip of the Chazy to the south of the marsh; we may, therefore, suppose that the concealed strata are the uppermost beds of the Chazy, which at Chazy village, six miles to the west, and at Valcour and at Grand Isle, consist largely of *Rhynchonella plena*. In fact, boulders of these strata are found on the shore of Isle La Motte to the south of the marsh.

The Crown Point Section.

Our third map represents the geological outcrop at Crown Point, N. Y., about forty miles south of Valcour Island. The region is one of unusual interest, as we here find representatives of all the formations that appear in the Champlain Valley from



CROWN PT., N.Y., AND VICINITY.

the Archean to the Utica slate. The measures of the Chazy here disclosed are as follows, in ascending order :

A	1.	Sandstone and slate interstratified	23 feet.
	2.	Impure limestone containing *Orthis platys* Bill	25 "
B		Beds containing *Maclurea magna*	200 "
C	1.	Dark gray, massive limestone, weathering in darker stripes an inch wide, containing *Bucania*, sp. und.	40 "
	2.	Tough, silicious and magnesian rock, passing into a two-foot bed of pure sandstone	17 "
		Aggregate thickness	305 feet.

North of Port Henry the Archean gneiss forms high bluffs on the west shore of the lake, and is well exposed for study by the extensive cuttings made in the construction of the D. & H. Railroad. West of the old furnace a large excavation has been made in the Archean limestone, which has been here quarried for flux. The village of Port Henry is underlain by the Potsdam sandstone, resting upon which may be seen the dark magnesian limestone at the base of the Calciferous. The railroad tunnel just west of the Bay State furnace passes through these strata, showing a northeastwardly dip of about 8°. North of the tunnel and extending to Craig Harbor is the pure limestone of *Group B* of the Calciferous, which is here, as well as elsewhere along the lake, a favorite source of flux for the iron-makers.

The higher measures of the Calciferous are to be found on the east side of the Crown Point peninsula. The rocks are largely covered with the Champlain clay, but the fossils would seem to indicate that we have here the strata of *Group D.* On the east shore of Bulwagga Bay we find the uppermost beds of the Calciferous underlying the measures of the Chazy as above described. From Bulwagga Bay the Chazy runs northeastwardly to the end of the promontory, and underlies the extensive ruins of the English fort and of the old French fort—Fort Frederick. Across the lake, which is here contracted to a width of twenty-five or thirty rods, the Chazy re-appears on Chimney Point, with a dip and strike indicating that the beds are continuous with the outcrop on Crown Point. They are terminated on the east by an oblique fault, with a downthrow on the east. The fault is well exposed on the lake shore just east of the Lighthouse ; and a few rods farther south we find the upper Chazy with a dip of

$11\frac{1}{2}°$ to the north. A similar fault occurs two miles farther south, where the Chazy appears in a downthrow, to the east of the Calciferous.

In the old fosse north of the English fort, near its entrance, may be seen the pure, dove-colored, brittle limestone at the base of the Black River, overlying the stratum of sandstone, which here as well as at Valcour caps the Chazy. The darker limestones of the Black River appear on the shore north of the fort, and were quarried in past years for black marble. Overlying them to the west are the ordinary strata of the Trenton. The Black River limestone may also be seen near the mouth of Hospital Creek, on the Vermont side of the lake, and extends northerly for nearly a mile, until apparently cut off by the oblique fault before mentioned.

To the west of this outcrop of the Black River there is a fine display of the whole of the Trenton limestone—on Crane's Point and at Norton's Bay. Its thickness is found to be 314 feet. To the north for several miles along the shore are exposures of the Utica slate.

In closing, we would call attention to the outcrops of the Chazy formation at Ball's Bay and at Providence Island, as represented in maps to illustrate the Calciferous, heretofore published in the 'Bulletin' of the American Museum of Natural History (Vol. III, pp. 15 and 18).

Index to Volume VIII.

[The names of new genera, species and subspecies, are printed in heavy-faced type.]

ERRATA.

Page 54, line 6, for '**Dycotyles**' read '**Dicotyles.**'
" 75, line 18, for 'Great Dame' read 'Great Dane.'
" 242, last line, for 'Microtus pallidus' read 'Microtus pauperrimus.'
" 288, last line, for *αγριος* read *ἄγριος*.

EXPLANATION OF PLATES.

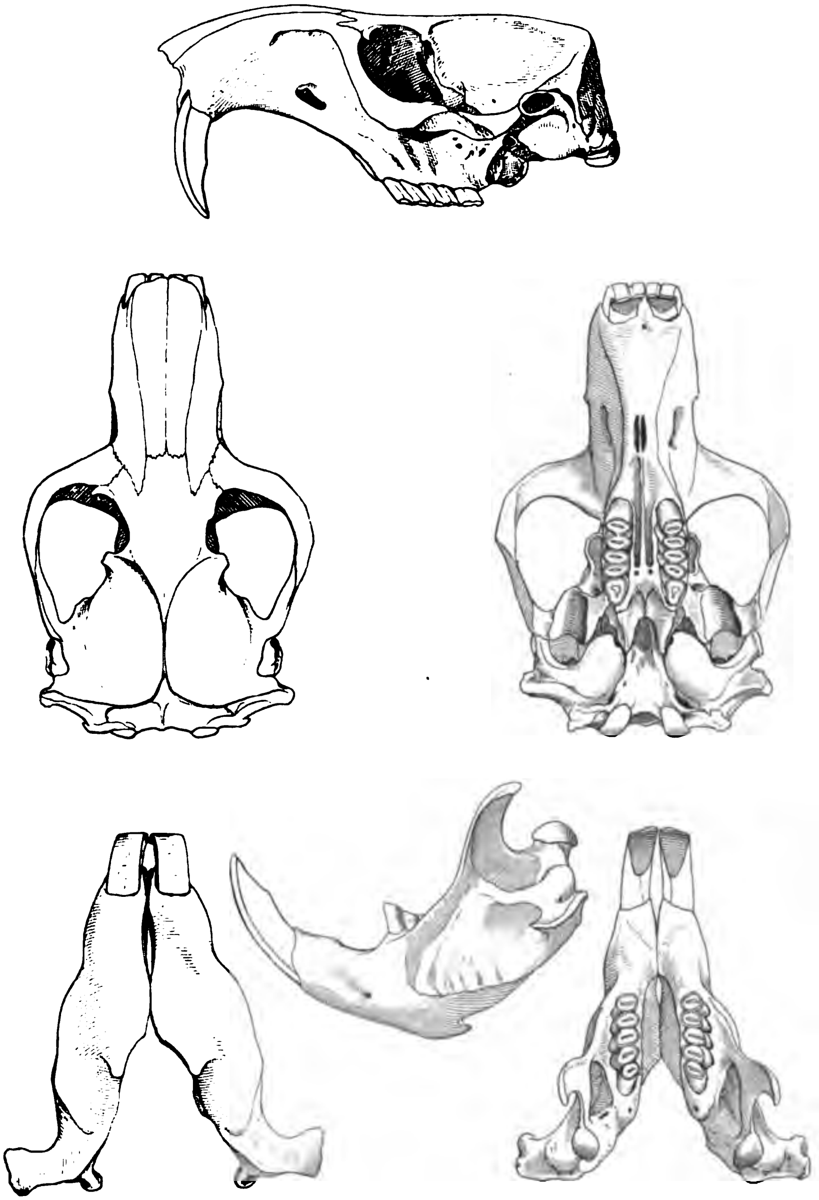
PLATE V.—General view of Temple, looking southwest across the narrow cañon through which the ascent is made.

PLATE VI.—View of the Temple, looking northwest.

PLATE VII.—Front of Temple, looking west.

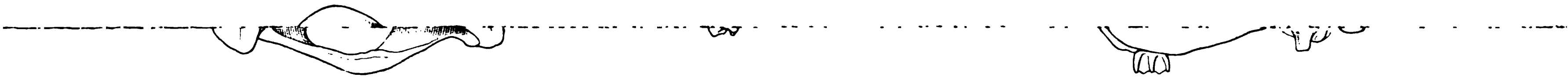
PLATE VIII.—Northern end of inner chamber, showing bench with sculptured front.

PLATE IX.—Ground Plan of Temple.



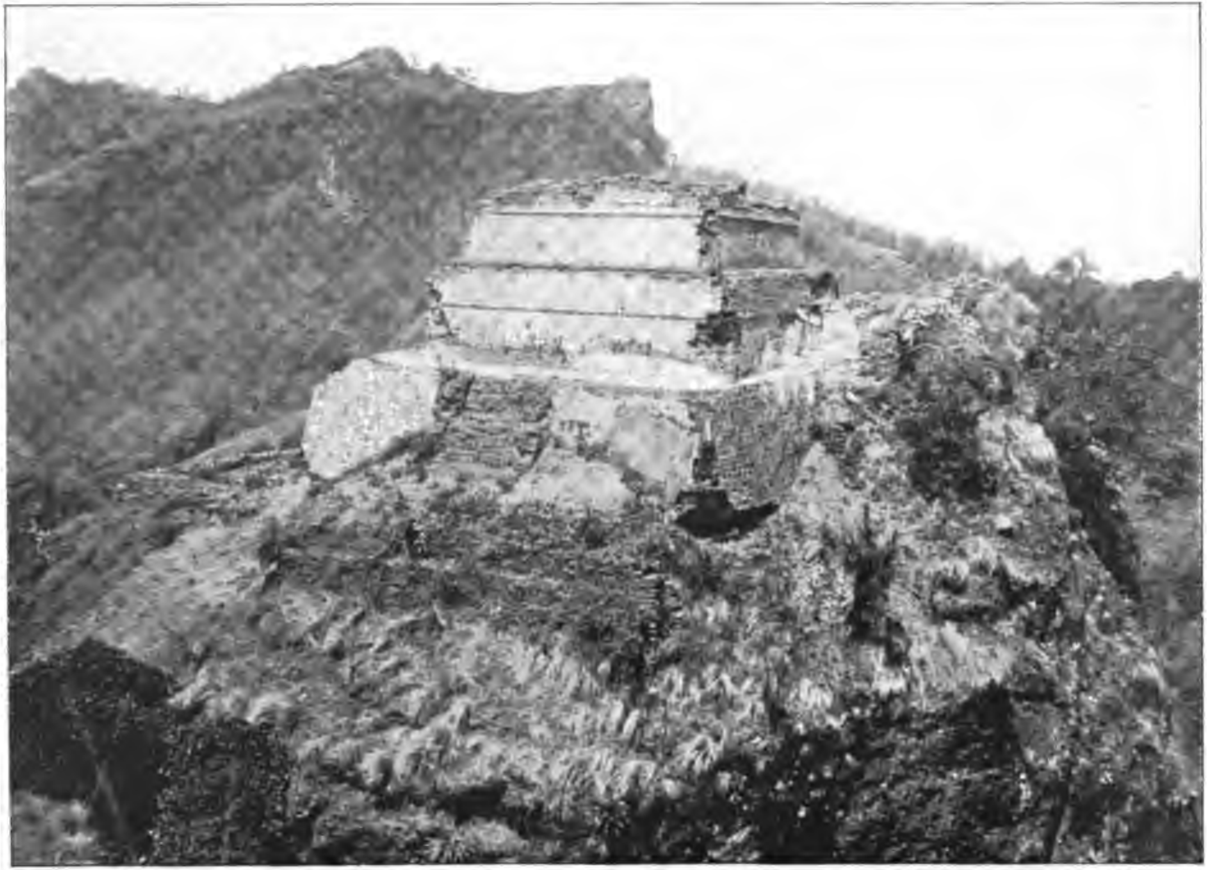
MACROGEOMYS CHERRIEI (*Allen*).

Figures all natural size.



Titanotherium trigonoceras. Type. × $\frac{1}{12}$.

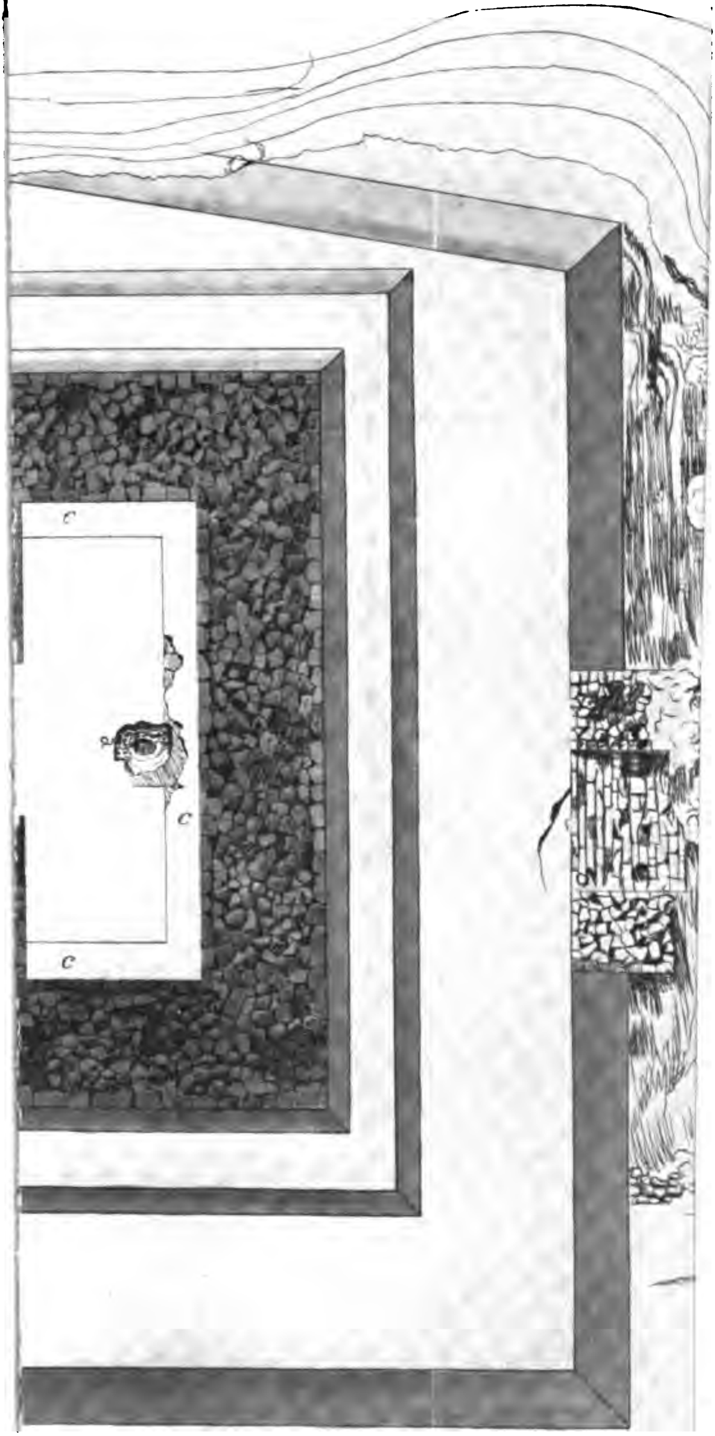
VIEW OF TEMPLE, LOOKING SOUTHWEST.



VIEW OF TEMPLE, LOOKING NORTHWEST.

Front of Temple, Looking West.

NORTHERN END OF INNER CHAMBER OF TEMPLE.



Francisco M. Rodriguez
Ingeniero y Arquitecto

RANGIFER TERRÆNOVÆ.

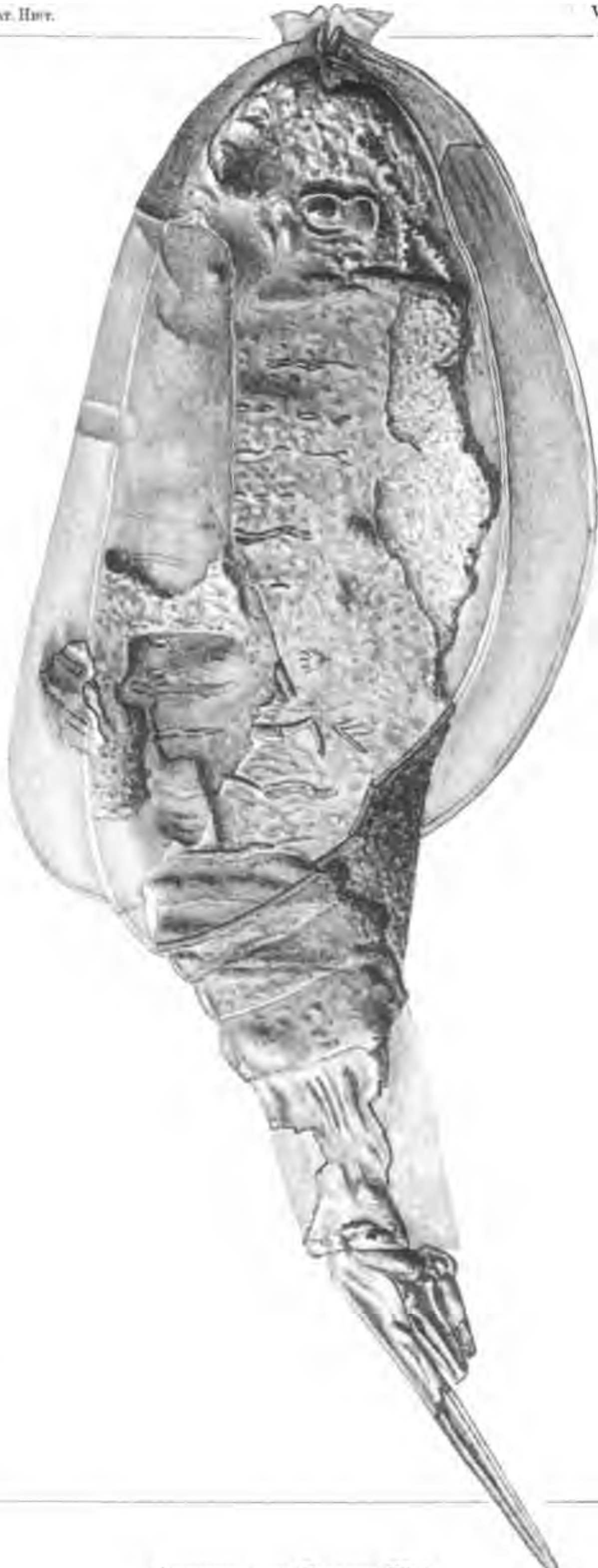
Antlers of Caribou.

Figs. 1, 2. Rangifer terrænovæ, ♂, ♀.
" 3, 4. " grœnlandicus, ♂, ♀.
" 6. " tarandus, ♂.

EXPLANATION OF PLATE XII.

Entomocaris telleri.

The figure is the only nearly entire individual observed, and is of natural size. It shows the right and left sides of the carapace a little displaced vertically, but preserving the outlines almost entire, the outer half having the posterior margin slightly faulted so as to throw it about a third of an inch out of line with the upper impression, which is the continuation of it, while the inner half is concealed over the same region by the overlying abdomen. The remains of the swimming feet are seen scattered along beneath the crust of the carapace, and show through its surface. The projecting outline in front of the carapace represents a thin film of crust which probably does not pertain to the animal, unless it may be a part of the mandibles.



ENTOMOCARIS TELLERI *White.*

EXPLANATION OF PLATE XIII.

Ceratiocaris monroei.

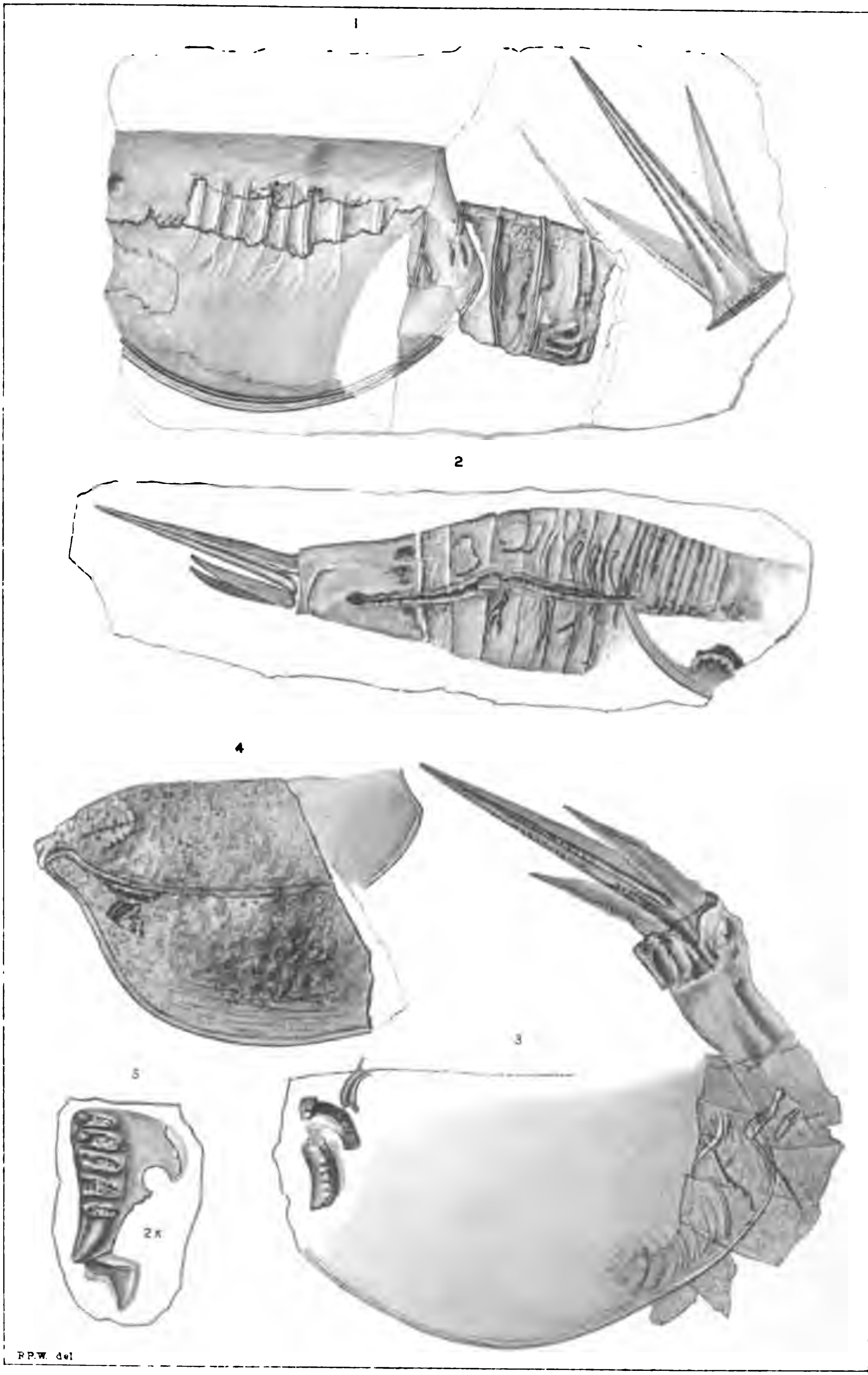
Fig. 1.—View of part of the carapace showing all but the anterior outline, and preserving much of the crust. The abdomen is seen, also preserving the test over the greater portion of its surface, and some indications of slender, bifurcating limbs to seven of the segments within the carapace. The caudal plate and spines shown in the figure may belong to the same individual, but they are on a lower layer of the shaly rock.

Fig. 2.—An abdomen with fourteen joints and the telson and spines, also a fragment of the border of the carapace and mandible. The depressed line along the abdomen is supposed to represent the intestinal canal.

Fig. 3.—View of another specimen showing part of a carapace, mandible, body segments and telson, with remains of swimmerets.

Fig. 4.—View of a fragment of a carapace showing the anterior rostral sinus. The carapace is folded on one side of the center, shortening the front side so as to make the two parts appear quite unequal.

Fig. 5.—An imperfect mandible in which the masticating tubercles have been broken. Enlarged two diameters.



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EXPLANATION OF PLATE XIV.

Entomocaris telleri?

Fig. 1.—View of a left mandible supposed to belong to this species. The manubrium has been ruptured and distorted. Enlarged two diameters.

Fig. 2.—View of a nearly entire right mandible. Enlarged two diameters.

Ceratiocaris monroei.

Fig. 3.—View of a right mandible showing the prevailing form seen. Enlarged two diameters.

Fig. 4.—View of the outer face of a form of mandible seldom found. Natural size.

Fig. 5.—View of an abdomen showing fifteen segments, with the imprint of several of the swimmerets and of what may have been the intestinal canal. Little of the crust is preserved, but the matrix preserves the imprint of the peculiar markings of the surface very distinctly.

Fig. 6.—Caudal plate and telson with the appendages flattened laterally, and showing the articulation very perfectly.

Fig. 7.—View of another specimen flattened obliquely and showing pointed margins to the last body segment.

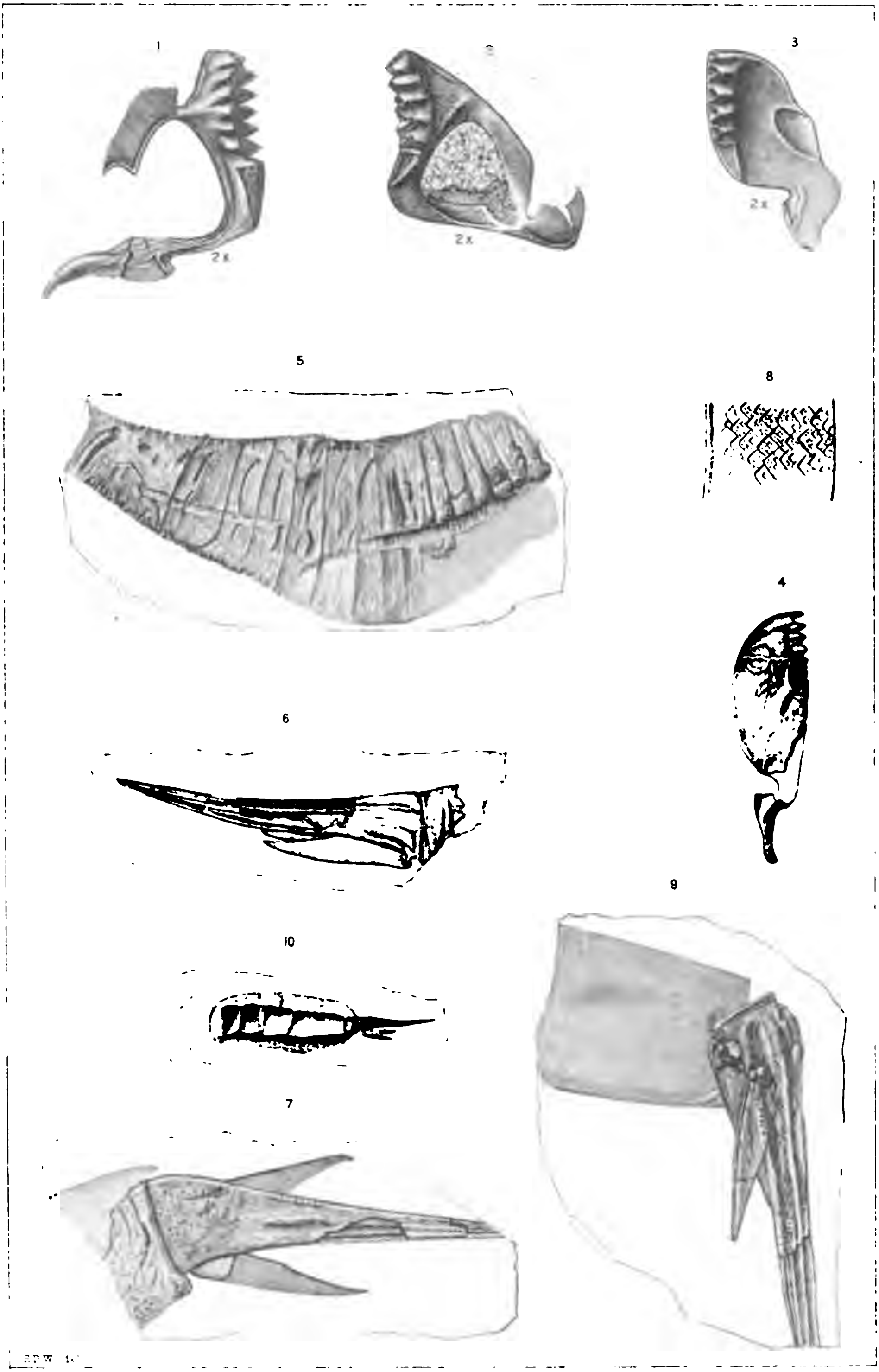
Fig. 8.—Enlargement of the zigzag surface ornamentation of the body segments.

Entomocaris telleri?

Fig. 9.—View of the terminal segment and caudal plate and spines which may belong to this species.

Ceratiocaris poduriformis.

Fig. 10.—View of the imprint of the type specimen, which retains part of the crust. Natural size.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